MARCH, 1952

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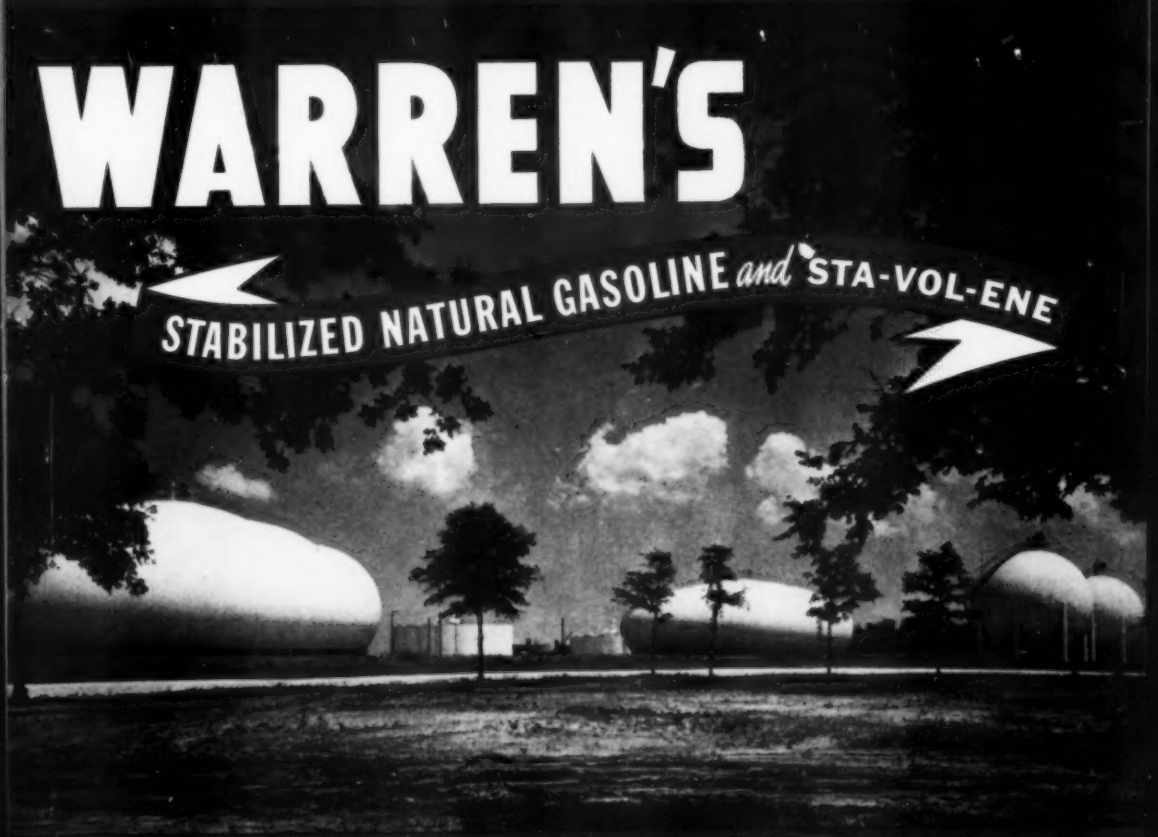

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Volume 31
No. 3

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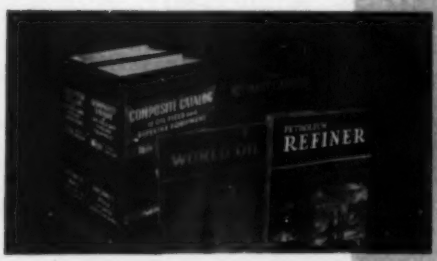

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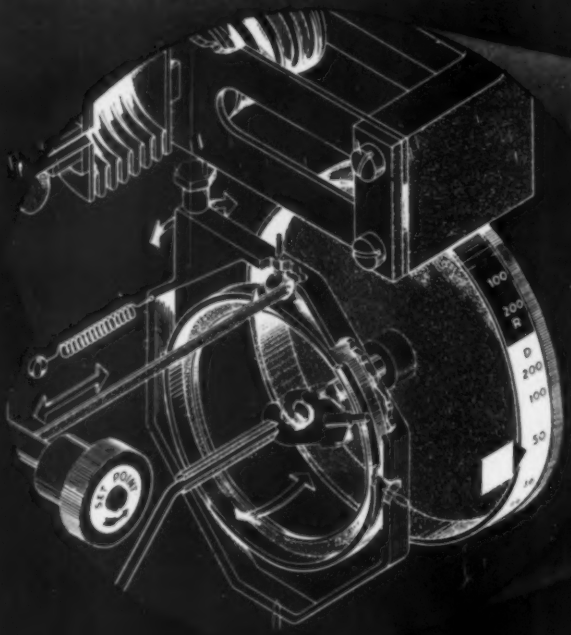

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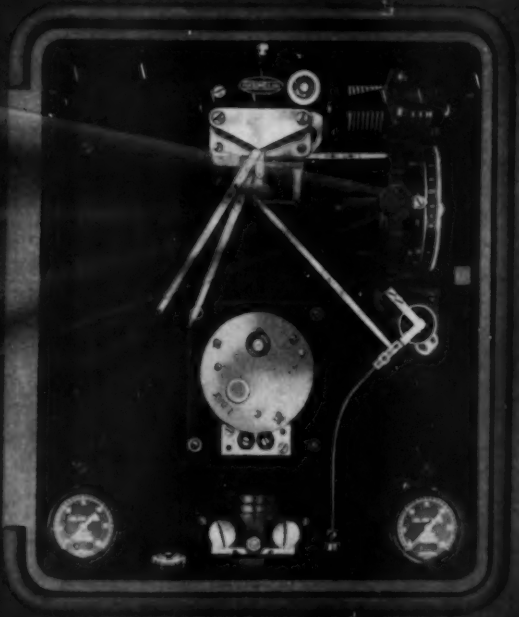

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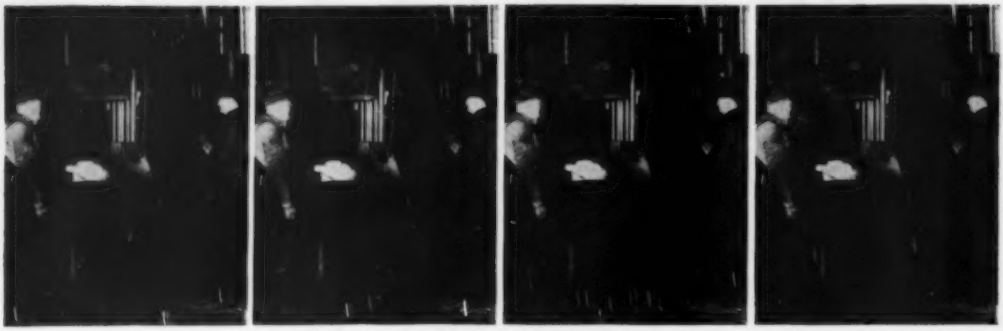

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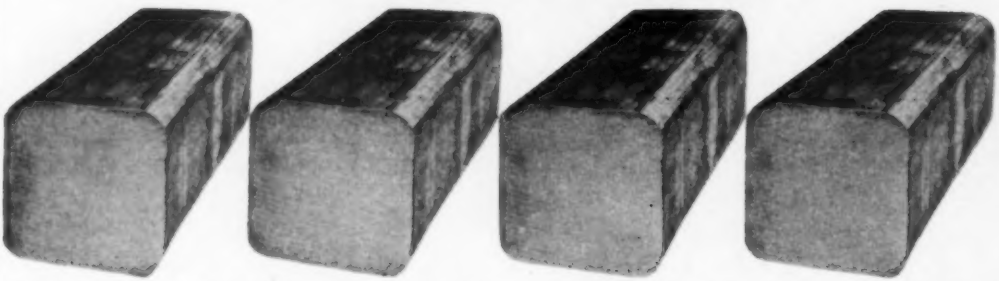

YOU can get uniform, high quality forgings and cut production costs too if you start by using uniform, high quality Timken® forging steels. With Timken forging steels, you're assured of uniform forgeability, uniform response to heat treatment, uniform machinability—from bar to bar and heat to heat. As a result, you have fewer rejects, fewer delays, fewer changes in shop practice.

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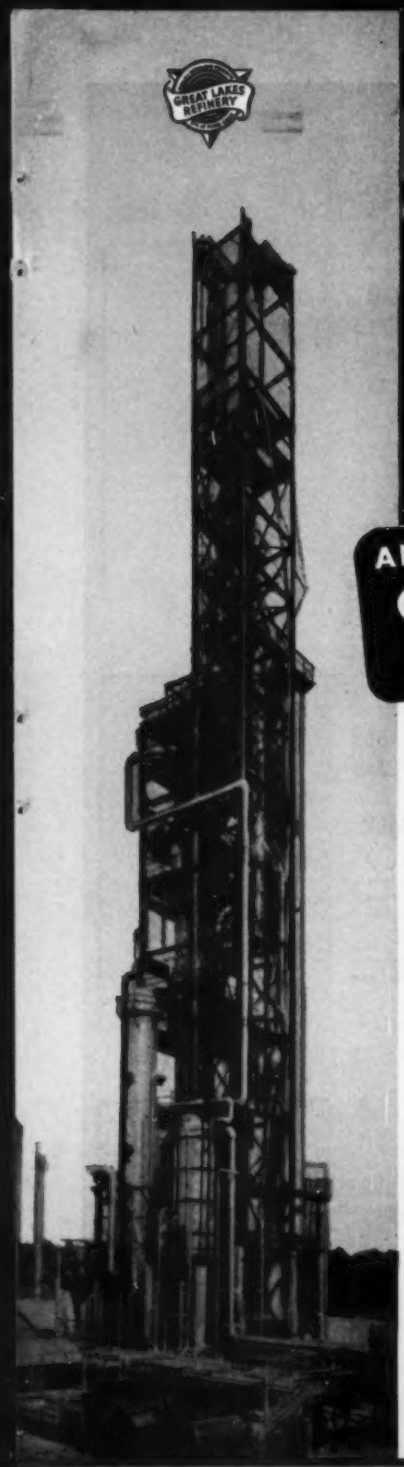
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



ALLIS-CHALMERS
Centrifugal
Blower

Supplies Air to New Houdriflow

ALL THE AIR NEEDED for catalyst regeneration *and* transportation in this new Houdriflow Catalytic Cracking unit is supplied by *one* Allis-Chalmers multi-stage centrifugal blower.

Put "on stream" in 1951, the unit is one of the many of its type already in operation. It is located in Blue Island, Ill. at the Great Lakes Refinery, a division of the Petco Corporation.

The new method extracts a higher percentage of gasoline from the crude and yet requires less equipment and instrumentation. The catalyst is both aerated and moved by the air from the one Allis-Chalmers multi-stage blower, rated 10,500 cfm at 12 psig. No mechanical means are required.

The blower and cracker operate 24 hrs a day, seven days a week, producing 6,000 bbls of gasoline per day. This particular refinery of the Petco Corporation has a daily capacity of 15,000 bbls and 300,000 bbls storage.

In the trend to more efficient cracking methods, the petroleum industry employs an ever-increasing number of centrifugal blowers. While one multi-stage blower is used in the Houdriflow process for two functions, other new cracking processes employ two single stage centrifugal blowers.

Your refinery expansion program also can benefit from Allis-Chalmers wide experience in building and applying blowing equipment in the petroleum industry. For more information or literature call your nearest A-C office or write Allis-Chalmers, Milwaukee 1, Wis. New Multi-Stage Bulletin 19B6104A is now available. A-3570

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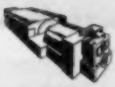
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CENTRIFUGAL PUMPS

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3 STANDARD METHODS OF RESTRICTING INNER VALVES

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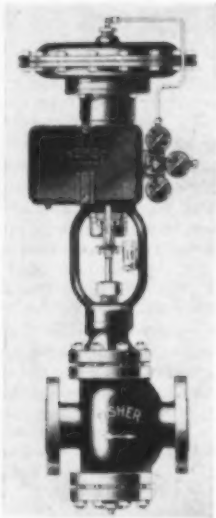

Reasons for using restricted trim: (1) where later conditions require either larger or smaller capacities, (2) a full sized valve body is desired for line strength but with low capacity requirements — Fisher 3 standard methods offer a quick, economical and completely satisfactory way of solving these problems.

Size of restriction available: Restricted Inner Valve ports should be held to minimum size of not less than 50% of standard port diameter for valve body size, or equivalent of 25% of maximum full size valve capacity.

Practical considerations have proven it is undesirable to reduce flow to less than 25% of maximum capacity of body in double ported valves.

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Marshalltown, Iowa

FISHER

LEADS THE INDUSTRY IN R

Underwriters' Laboratories, Inc.
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ELECTRIC MOTOR FOR HAZARDOUS LOCATION
ELEC CLASS I GROUP D AND NO.
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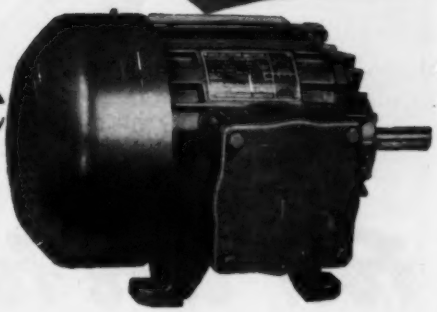
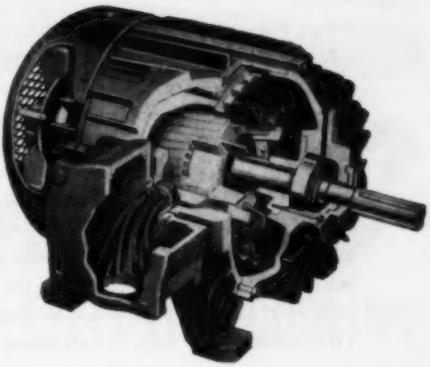
Look Outside



Greatly increased radiating area means greater cooling efficiency. More important, cooling efficiency stays high. There are no enclosed external air passages to clog and cause overheating. If oily dirt sticks, just wipe or blow it off. No matter how bad operating conditions are, this motor can easily be kept clean and cool-running. Electrical parts are protected against corrosive atmospheres by cast iron yokes and end housings.

Look Inside



Double-shielded, heavy-duty ball bearings require no maintenance in ordinary service under most conditions. However, they can be lubricated without disassembly if required. Double shielding prevents over-lubrication, leading cause of bearing trouble. Rotating seals, where shaft extends through housings, keep dirt and moisture out of bearing chambers. Deep rabbet fits between frame and end shield; heavy ribbing and long flame seals on shaft more than meet Underwriters' label requirements for Class I, Group D and Class II, Groups F and G locations.

See *WHY THIS IS YOUR BEST MOTOR BUY*

HERE IS AN EXPLOSION-PROOF MOTOR that is different from conventional explosion-proof motors; built with an entirely different cooling system that gives you big savings in lower maintenance costs, more continuous service and less trouble in toughest locations. Clogging can easily be prevented in the Allis-Chalmers Type APZZ explosion-proof motor since areas that might collect dirt are exposed and easy to clean. And, of course, it's ideal for outdoor installations.

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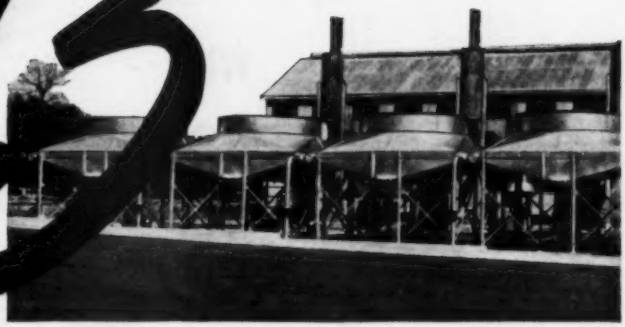
Y2-4

on the Tennessee Gas Transmission Pipe Line

213 ALCO AIRCOOLERS



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4. EASY MAINTENANCE—fewer parts, easy accessibility and better wearing characteristics.

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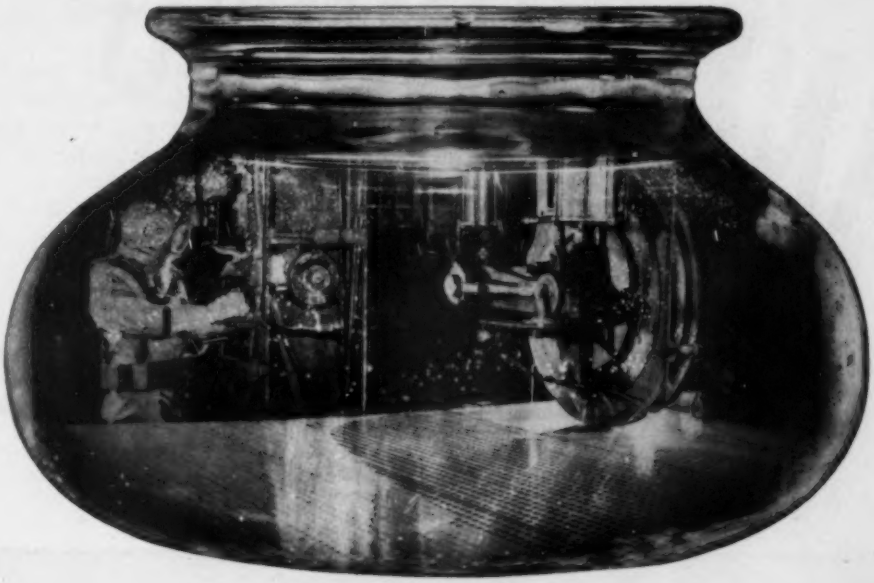
- Excellent performance at relatively high operating temperatures
- Superior performance in fresh, salt or brackish waters

SCOVILL HEAT EXCHANGER TUBES

"You can't buy better brass"

SCOVILL

A PRODUCT OF SCOVILL



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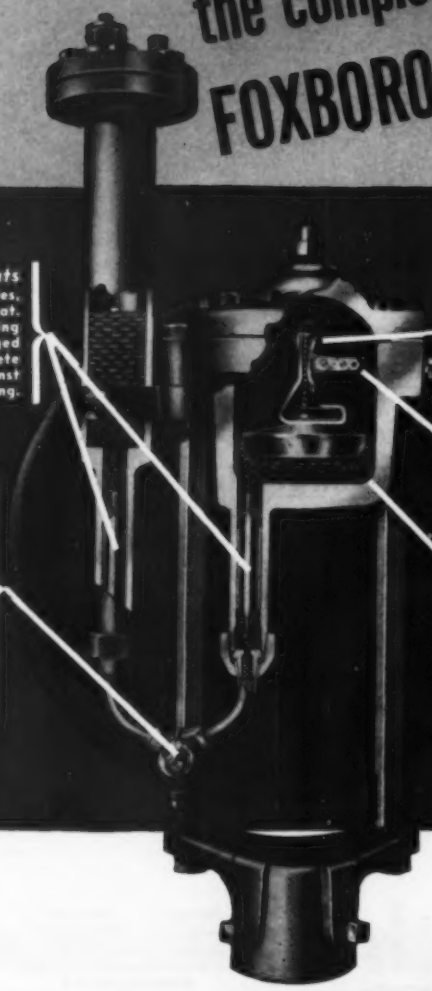

NEW Check Floats with redesigned guides, ball plug and seat. Insure perfect seating every time! Submerged in mercury for complete protection against frosting and fouling.

NEW U-Bend and Damping Plug Assembly. Easy to make up tight every time because of self-aligning all-welded construction. No gasket needed. Replaceable seats. Damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

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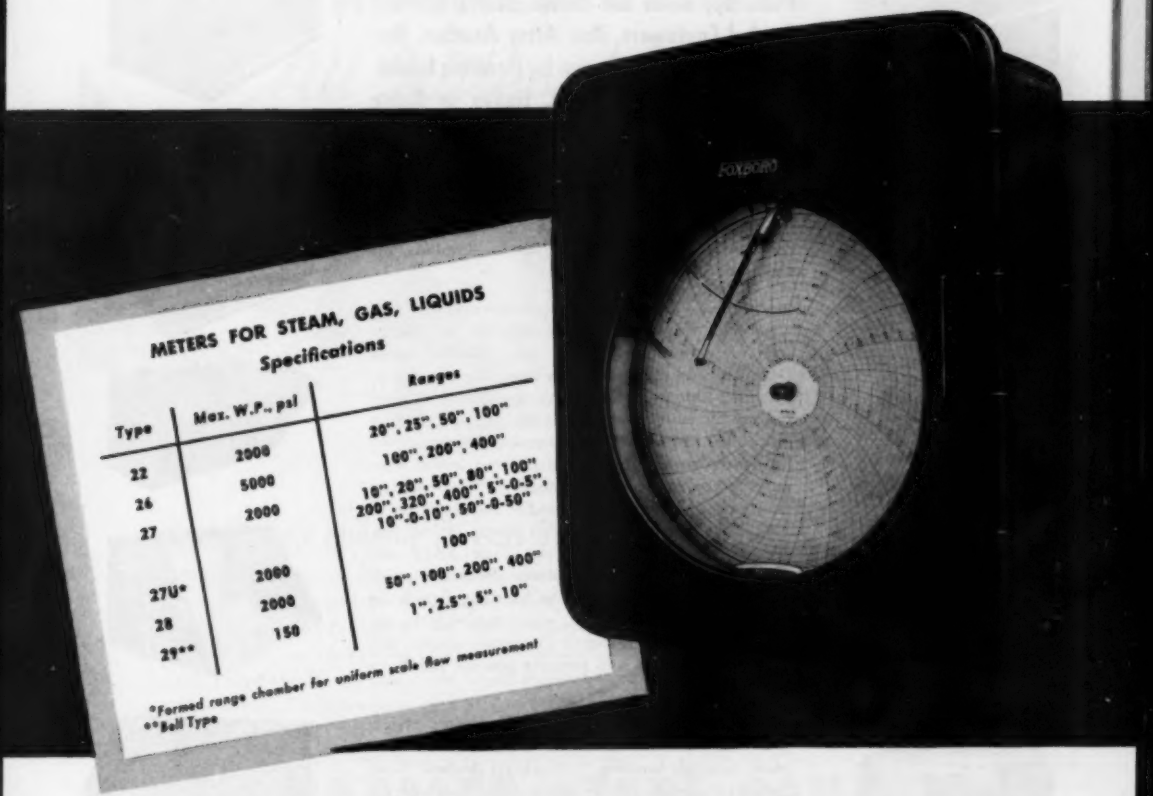
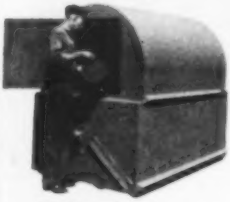


. . . First in FLOW METERS

How The Dempster-Dumpster System Cuts Cost of Equipment . . . Eliminates Re-Handling of Materials!

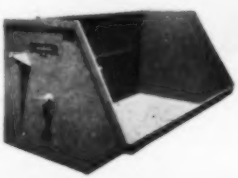


One Truck-Mounted Dempster-Dumpster Picks Up, Hauls and Dumps Scores of Pre-Loaded Containers, One After Another, Regardless of Size or Design for Handling Liquid, Solid, Trash, Dust, Light, Heavy or Bulky Materials.

You can eliminate large investments in trucks, reduce the cost of gas, oil and maintenance . . . avoid time lost by loading crews while trucks make haul . . . and eliminate re-handling of materials by installing the Dempster-Dumpster System!

In the first place, three to five conventional dump trucks with crews cannot possibly do as efficient and economical a job as one truck-mounted Dempster-Dumpster with only one man, the driver. Dempster-Dumpster Containers are spotted at convenient accumulation points inside and outside your plant. The driver and his Dempster-Dumpster are constantly on the move servicing one loaded container after another. The Model LFW Dempster-Dumpster illustrated above handles containers up to 12 cu. yd. capacity. Containers up to 21 cu. yds. are available for use with our Type ARLF and Type DTLF Dempster-Dumpsters. Your Dempster-Dumpster and driver may be handling liquids on one haul, solids on another, waste materials on another, etc. The Dempster-Dumpster driver can pick up a load, put it in carrying position and dump it in 2¼ minutes!

Without question, the Dempster-Dumpster System is the most economical and most efficient method of plant materials handling by truck yet devised! Write today for complete information. Manufactured exclusively by Dempster Brothers, Inc.



DEMPSTER BROTHERS, 532 Dempster Bldg., Knoxville 17, Tennessee

Bubble Cap Bulletin 21 Lists 200 Styles

As fabricators of the largest choice of bubble caps, The Pressed Steel Company is saving many customers the cost of dies, in addition to savings in design and delivery time. And, because PSC fabricates from the complete list of alloys, we are repeatedly able to solve our customers' coking and corrosion problems.

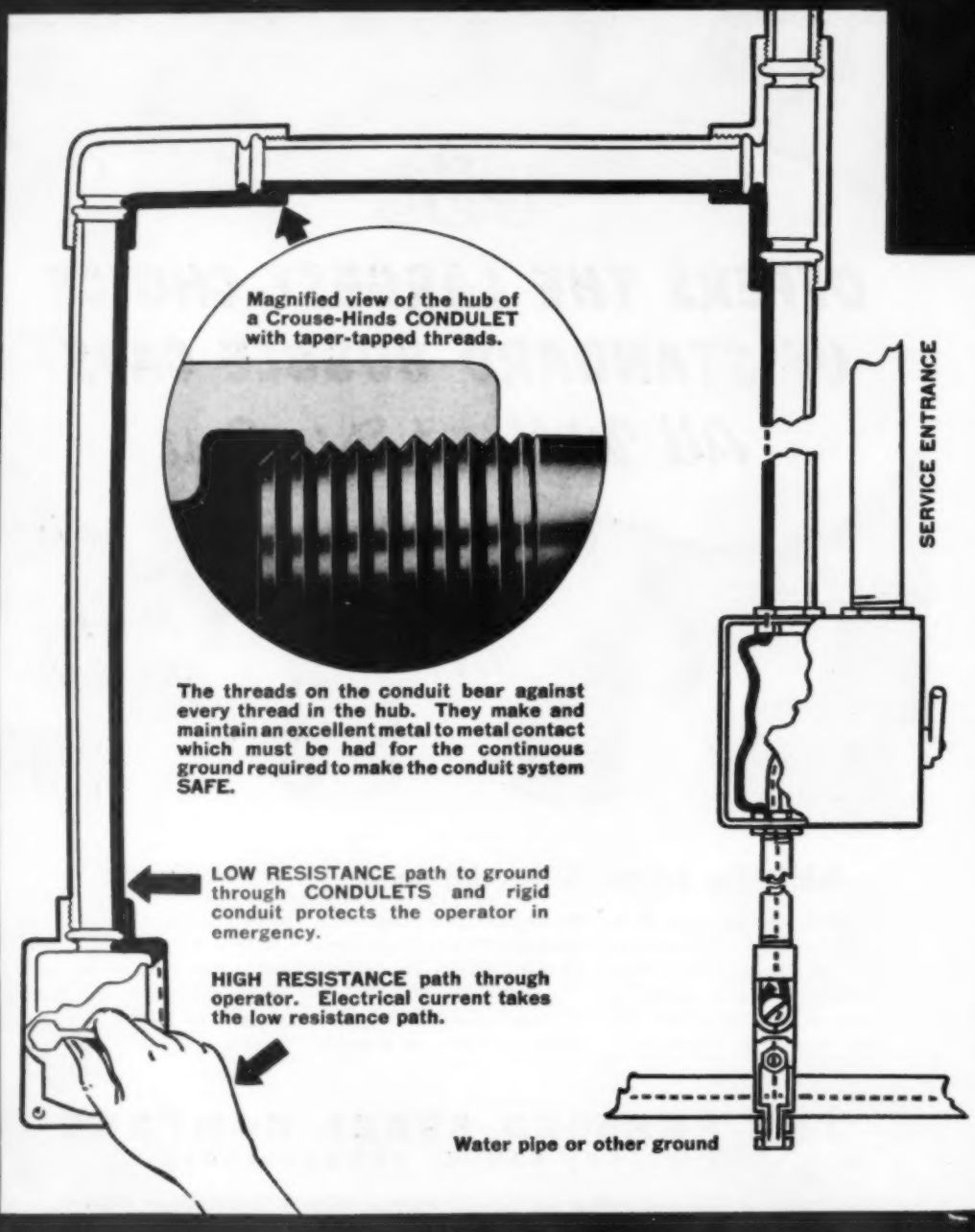
You will find in PSC Bulletin 21 the largest compilation of engineering data on bubble caps. Complete information is presented for each of the over 250 standard styles of bubble caps and risers furnished by The Pressed Steel Co. Also drawings for use in determining methods of tray assembly. Special caps promptly designed. Send blue prints.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

CONDULETS* and rigid conduit


Magnified view of the hub of a Crouse-Hinds CONDULET with taper-tapped threads.
The threads on the conduit bear against every thread in the hub. They make and maintain an excellent metal to metal contact which must be had for the continuous ground required to make the conduit system SAFE.
LOW RESISTANCE path to ground through CONDULETS and rigid conduit protects the operator in emergency.
HIGH RESISTANCE path through operator. Electrical current takes the low resistance path.
SERVICE ENTRANCE
Water pipe or other ground

... the wiring method that gives you maximum SAFETY for workers AND property

Typical CONDULETS

Type T Obround Conduiet

Type LR Obround Conduiet

Type FS Conduiet

Type WMK Enclosed Safety Switch Conduiet

Type VC Vaportight Industrial Lighting Fixture

Type EVA Explosion-Proof Industrial Lighting Fixture

Type GUAC Explosion-Proof Junction Conduiet

Type EPC Explosion-Proof Line Starter

A low resistance grounding circuit is of vital importance in any electrical system. The combination of rigid conduit and CONDULETS provides the safest installation because this combination assures the permanence of the grounding circuit. In any grounding path, every joint that isn't tight in the beginning or loosens from vibration makes a high resistance point. Such high resistance creates a hazard for workers and can cause disastrous fires.

All rigid conduit has tapered threads and all CONDULETS (made only by Crouse-Hinds) have taper threaded hubs. This combination makes a secure joint that is tight in the beginning and stays tight. These joints will not loosen from vibration and assure a reliable and permanent low resistance path to ground. This SAFETY feature provides maximum protection against personal injury and fire.

Besides safety, a CONDULET installation gives you these additional definite advantages:

- **MECHANICAL PROTECTION.** Crouse-Hinds sturdy cast Feraloy CONDULETS and rigid conduit provide the best possible protection against accidental damage to the wiring and equipment. Prevents costly shutdowns.
- **FLEXIBILITY.** To meet all the diverse requirements of modern electrical layouts, CONDULETS are made in a wide variety of shapes and sizes with varied hub arrangements, including a full line of CONDULETS with detachable hub plates.
- **ECONOMY.** The installed cost of Crouse-Hinds CONDULETS and rigid conduit compares favorably with other wiring methods. The added advantages make it the really economical method that pays dividends over the years.
- **CORROSION RESISTING.** Cast Feraloy CONDULETS give the best protection wherever moisture, dust, or corrosive atmospheres are present.
- **UNIVERSAL APPLICATION.** You can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies.
- **QUALITY.** The trademark CONDULET stands for the highest quality, reliability, and long life.
- **VARIETY.** More than 15,000 items are listed in the CONDULET Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations.

On YOUR next electrical layout, plan to get all the benefits of sturdy cast Feraloy CONDULETS and rigid conduit . . . the universal wiring method.

* *CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Albuquerque—Birmingham—Boston—Buffalo—Chicago—Cincinnati—Cleveland Dallas—Denver—Detroit—Houston—Indianapolis—Kansas City—Los Angeles—Milwaukee Minneapolis—New York—Philadelphia—Pittsburgh—Portland, Ore.—San Francisco Seattle—St. Louis—Washington. RESIDENT REPRESENTATIVES: Albany Atlanta—Baltimore—Charlotte—New Orleans—Richmond, Va. Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

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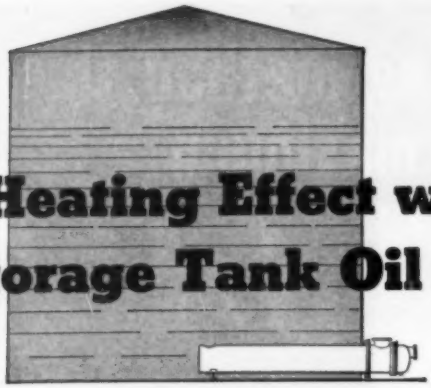
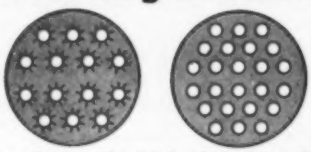


Greater Heating Effect with the G·FIN Storage Tank Oil Heater

because....

1.

Greater Access of Oil to Heating Elements



At left is a tube sheet of a G-R finned-tube heat exchanger. At right is a tube sheet of a typical bare-tube heat exchanger. Note the greater access space between tubes in the G-R exchanger.

2.

Greater Heating Surface of G·FIN Elements

Even in sub-zero temperatures, the G-R G-Fin Storage Tank Oil Heater assures a steady flow of oil soon after the steam is turned on. That's because (1) the wider tube spacing allows the viscous oil greater access to the tubes than in a conventional heater and (2) the G-Fin elements provide six to eight times the heating surface of bare tubes.

Greater heating effectiveness is only one of the important reasons why users prefer the G-R G-Fin Storage Tank Oil Heater. These units use less steam because they heat oil only locally at point of withdrawal. The straight-through flow of oil results in minimum pressure drop. There's no stratification or vapor binding because the oil outlet is located at the top of the shell. And there are fewer tubes and tube joints to maintain.

These and other advantages of the G-Fin Storage Tank Oil Heater have been fully proved in thousands of installations. Write for Bulletin 1642 describing these units in detail.

TYPICAL APPLICATIONS OF G-R G-FIN STORAGE TANK OIL HEATER

STORAGE TANKS—containing heavy oils, tar or asphalt at refineries, tank farms, etc.

SERVICE TANKS—serving oil-burning boilers at central power stations, industrial plants.

LOADING WHARVES—to speed up transfer of oil to and from tanks, lighters, barges or cars.

CHEMICAL PLANTS—wherever viscous oil or other liquids must be transferred in bulk.

GAS PLANTS—where by-product tar or heavy oils must be heated.

MISCELLANEOUS—for heating cottonseed oil, molasses, road oil and other viscous liquids.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GR-223

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

HERE'S A GOOD COMBINATION FOR High-Temperature Bolting

When you encounter particularly tough bolting conditions in high-temperature, high-pressure service, use the Bethlehem Continuous-Thread Stud, together with two Bethlehem Quenched Nuts. This combination of fasteners is economical because it resists creep and premature failure induced by high temperatures and pressures, and therefore helps to minimize down-time.

BETHLEHEM CONTINUOUS-THREAD STUD—This stud is ideal for difficult bolting jobs because it minimizes stress concentrations. Has no point of thread runout. Consequently, stresses cannot concentrate at any given point to cause premature failure. Instead, the stresses are well distributed over the entire working length of the stud.

BETHLEHEM QUENCHED NUT—A forged nut, made from high-quality 40-to-50 carbon steel. After forging, the nut undergoes controlled quenching and tempering, arming it with sufficient strength to develop the strength of any stud or bolt on which it is used.

WIDE SIZE RANGE

The Bethlehem Continuous-Thread Stud and the Bethlehem Quenched Nut are made in a wide size range. They make a good combination—one which you can use with complete assurance that it will do the job. Full details from the nearest Bethlehem office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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PEERLESS PUMPS

1–MAXIMUM PARTS INTERCHANGEABILITY
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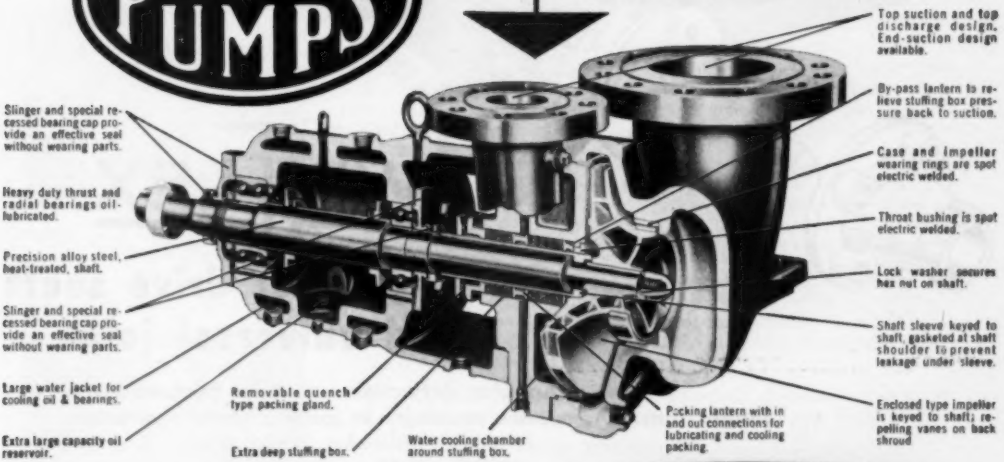
4–OPTIONAL USE OF MECHANICAL SHAFT SEAL INSTEAD OF STUFFING BOX
5–AVAILABILITY IN VARIOUS ALLOY MATERIALS
6–END-SUCTION OR TOP-SUCTION DESIGN
7–A COMPLETE RANGE OF SIZES

Plus ALL THESE IMPORTANT DESIGN AND CONSTRUCTION FEATURES!


Top suction and top discharge design. End-suction design available.
By-pass lantern to relieve stuffing box pressure back to suction.
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Angular deflection and load fluctuation no longer constitute service problems in cooling tower operation.

By applying power through pre-loaded, bonded-to-metal inserts of pressure moulded neoprene, TWINFLEX drives fully compensate for starting loads and misalignment. This means protection to costly bearings and gears, and eliminates maintenance. These universal joints require no lubrication . . . in fact are impervious to oil as well as water. TWINFLEX dynamically balanced drive shafts are of electro-galvanized tubular steel and are sealed against internal corrosion. The TWINFLEX Drive shaft and universal joint are the first application of this most modern design power transmission to cooling towers . . . another in the long line of exclusive engineering advancements that makes Marley the world's largest producer of water cooling towers.

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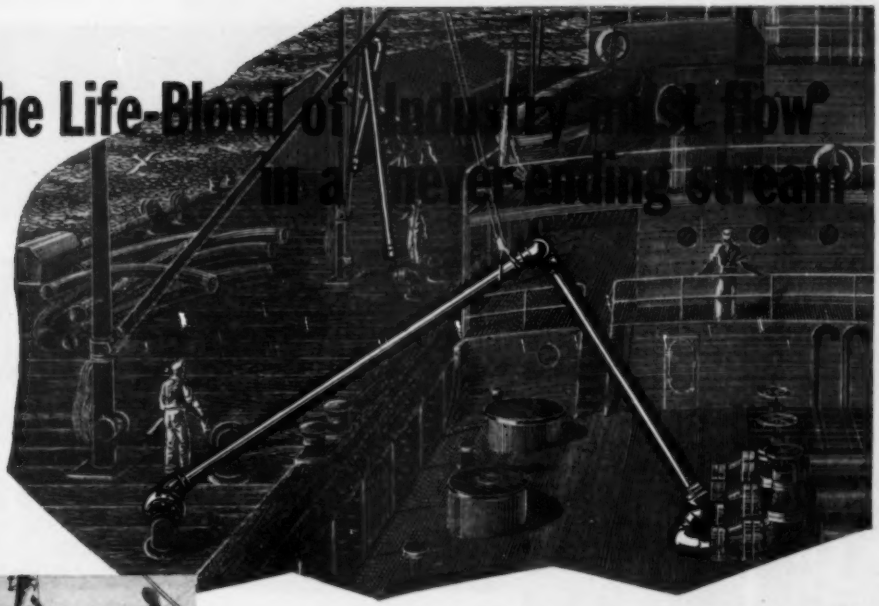
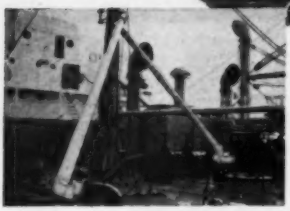
The Life-Blood of Industry must flow in a never-ending stream





Chiksan Marine & Barge All Metal Hose is not subject to kinking, crushing or cutting. This World renowned Metal Hose is not affected by severe climatic conditions or by petroleum products which often cause other hose to deteriorate rapidly. Thus Chiksan will outlast any other Hose used in these applications.

Chiksan Aluminum Marine & Barge Hose—facilitates Dock-Side—to Ship-Side connections by one man in a few moments. Speed, economy and safety are established factors where Chiksan equipment is used.

Chiksan Marine & Barge Hose and Chiksan Ball Bearing Swivel Joints can be supplied in any required length and size with end connections in either aluminum or steel for above-surface or underwater service.

When the Gatun Locks of the Panama Canal raise or lower their floating burdens of commerce and defense—when brine courses in uninterrupted flow to keep milk fresh and sweet—there you will find Chiksan Ball Bearing Swivel Joints speeding the life blood of industry—hastening the flow of progress.

Developed to conquer the rugged requirements of the World's Oil Fields, these joints have found application wherever gas, liquid or other fluid needs flexibility of material and direction; whenever Speed—Safety and Economy are essential to prosperity and growth.

Chiksan Ball Bearing Swivel Joints transform rigid ferrous metals, copper, brass or alloys into snaking tubes that have the elasticity-of-operation—the flexibility-of-function of rubber, and yet provide the safety factors and stoutness of heart that only well wrought metal can bring to industrial applications.

With Chiksan on the job, the torturing heat of steam cannot break through, nor can the relentless pound of exceedingly high pressure find escape.

Metal, heretofore unyielding, now twists and flexes to your will and to follow the plan and blueprint of industrial engineer. Each Chiksan Swivel Joint turns and twists like a living organism—speeds the flow of fluid and industry—of progress and defense.

Oil flowing in and out of a tanker—milk coursing its hygienic route from dairy to table—drill fighting its tortuous way through rock, shale and sand—coolant of the lathe and union of fire hose to truck—all know the live action—the flexibility and staunchness—the longevity and economy of Chiksan Ball Bearing Swivel Joints—connecting links in the Circulatory System of Industry, Defense and America in Action.

The Flow of Enterprise Relies on CHIKSAN Ball Bearing Swivel Joints

Write for Complete Chiksan Catalog—Dept. 3-PR.

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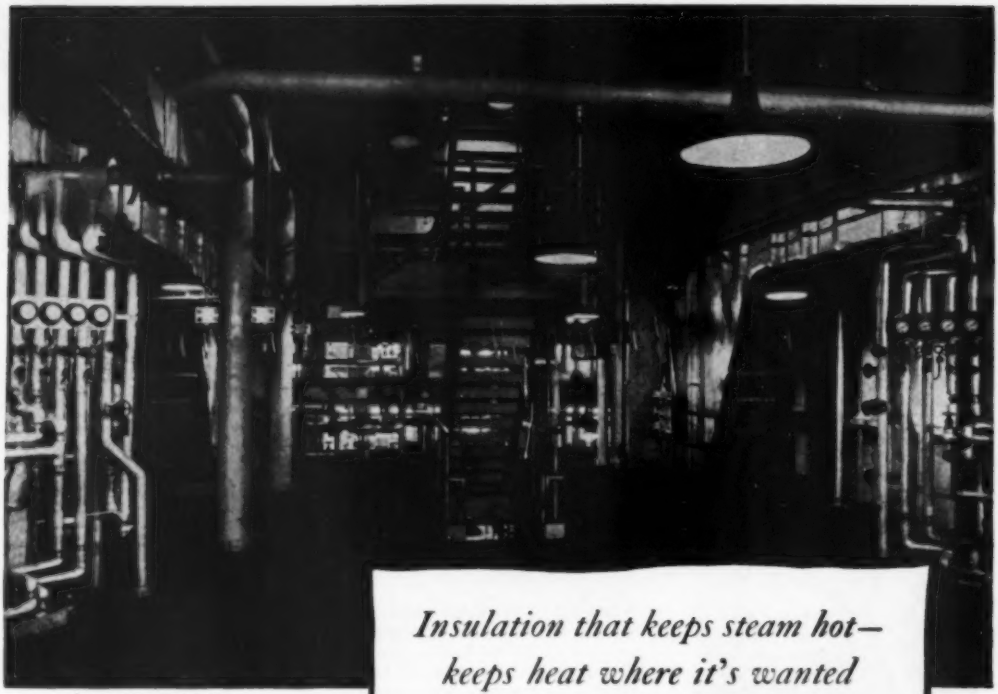

Large eastern power station:
Piping insulated with "Featherweight" 85% Magnesia, sewed canvas jacket; ducts with 1½" "Featherweight" blocks and ½" thickness of cement.
Insulation Contractor:
Armstrong Cork Company.

Insulation that keeps steam hot—keeps heat where it's wanted

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"FEATHERWEIGHT"® 85% MAGNESIA

—insulation that delivers more steam at less cost! For more than 60 years "Featherweight" 85% Magnesia Insulation has been known throughout industry for outstanding efficiency in all heating applications up to 600° F. You'll find it in power stations and steamships, in hospitals and food processing plants, in oil refineries and chemical installations—in fact, wherever exacting steam temperature control is a must.

And "Featherweight" 85% Magnesia not only gives you efficiency, but also extreme durability. It is structurally strong; can withstand reasonable amounts of compression, vibration, and contact. Physically inert, "Featherweight" will not spall or crack when subjected to the alternate heating and cooling of steam system start-ups and shut-downs. And, being entirely mineral in nature, it will not burn. In short, it is difficult to overestimate the efficient life of "Featherweight" 85% Magnesia. In most cases, it will outlast the heating system!

Your Keasbey & Mattison Distributor, who is an experienced applicator, will be glad to give you complete information on "Featherweight" 85% Magnesia. Or, write us direct.

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Nature made Asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

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This is Controlled Volume Pumping

Handling liquefied gas:
pumping 8.0 gph of
compressed liquid
Ethylene at 15,000 psi.
Temperature 0° C.
Suction Pressure 1000 psi.

THIS MILTON ROY CONTROLLED VOLUME PUMP DOES THE JOB . . .

It's a Milton Roy High-Pressure Simplex, operating in the research lab of a major chemical company. Here are a few of the requirements this pump satisfies: Slow speed on the suction stroke to prevent "flashing" of the liquid Ethylene into a gas; special metallic packing which eliminates all leakage, withstands the 15,000 psi compression; refrigeration through the jacketed liquid end to maintain the Ethylene in a liquid state; explosion proof operation—liquid Ethylene mixed with prescribed percentage concentrations of air is explosive. Field reports indicate complete operating efficiency of this unit.

The successful pumping of a hydrocarbon of the peculiar and difficult nature of liquid Ethylene indicates the versatility of Milton Roy Controlled Volume Pumps. The fact that liquid Ethylene is an important building block for many organic compounds—used in anti-freezes, plastics, insecticides, resins etc.—makes high-pressure pumping of this liquid in controlled volume an industrial necessity.

And for those diversified liquids usually considered as gases at normal temperatures and pressures—carbon dioxide, Butane, Vinyl Chloride, Propane, Propylene, to mention just a few, Milton Roy Controlled Volume Pumps have pin-point application. They give flawless service.

Call the Milton Roy representative listed in your classified telephone directory for additional information on Milton Roy Controlled Volume Pumps for *your* specific process problem. Or write us direct.

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MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

No matter what size power units you need, Master Gearhead Motors are the horsesense way to use horsepower. No matter whether you use big ones or little ones, you get the RIGHT horsepower, the RIGHT shaft speed in a single unit that will fit in RIGHT where you need it. The integral construction of both motor and speed reducer into one compact unit, permits many parts to be stripped away from both the power drive and the completed machine, and pays off handsomely in savings in material . . . savings in space. In big sizes or small sizes, you'll find them easy to order, easy to use . . . a great help in securing compact, clean-cut, economical designs for your equipment.

And nowhere, except in the Master line of Gearmotors, will you find power units that are so flexible, so easily adaptable, and in such a wide range of sizes and types. They are available in any size, 100 HP and smaller . . . and for all cycles, phases and voltages . . . in open, splash proof, totally enclosed, fan cooled and explosion proof types . . . with Speedrangers (mechanical variable speed) and Unibrakes . . . for every type mounting . . . and over a gear reduction range up to 432 to 1

Increase the salability of your motor driven products . . . improve the economy, safety and productivity of your plant equipment . . . with Master Gearhead Motors, the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

BIG ones or little ones

MASTER GEARMOTORS

WILFLEY Acid PUMPS

A shipment of Wilfley Acid Pumps destined for a South American installation.

Today's demand for increased production in the chemical industry has spotlighted the absolute dependability of WILFLEY Acid Pumps. In chemical plants all over the world this great pump is making impressive production records in low-cost handling of acids, corrosives, hot liquids, mild abrasives and other solutions. 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Wetted parts of practically all machinable alloys. Plastic lined models available. Individual engineering on every application.

Companion to the famous Wilfley Sand Pump

Bulletin E-7000 shows Model "AF" Acid Pumps in direct-drive, belt-drive and overhead belt-drive models. Write or wire for your copy today.

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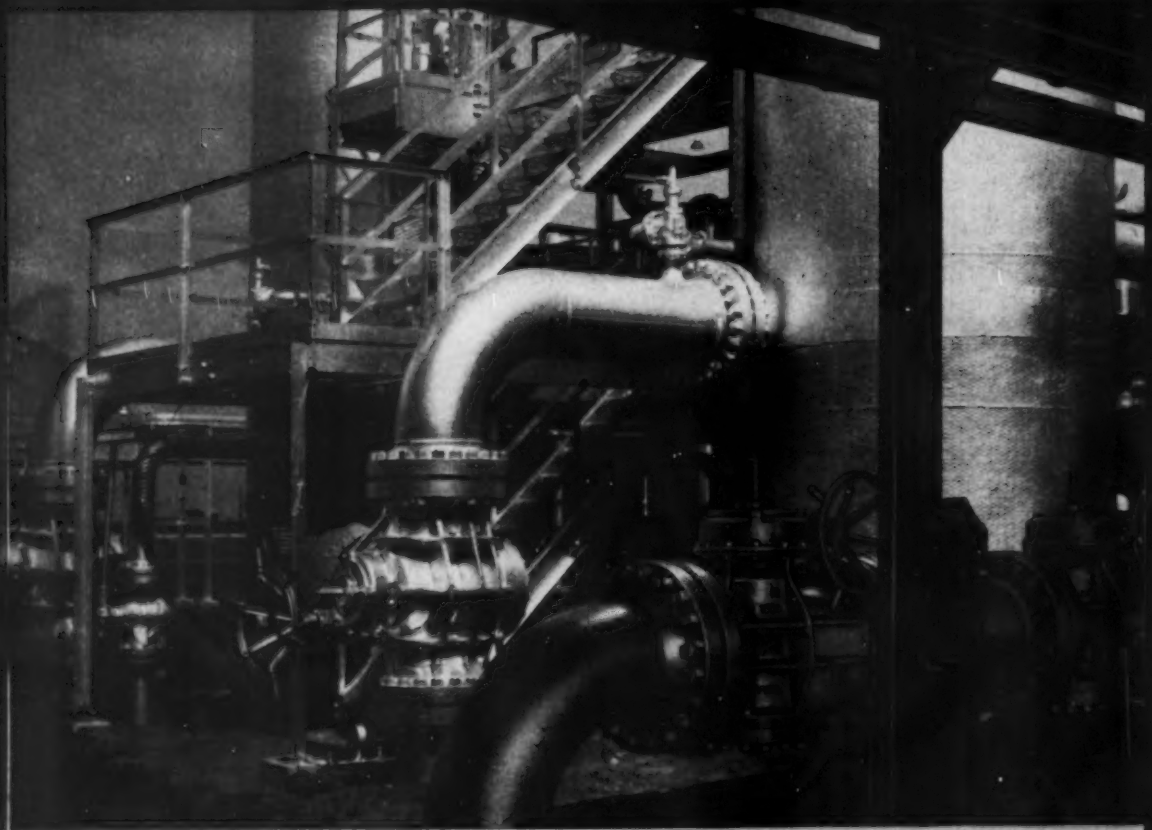
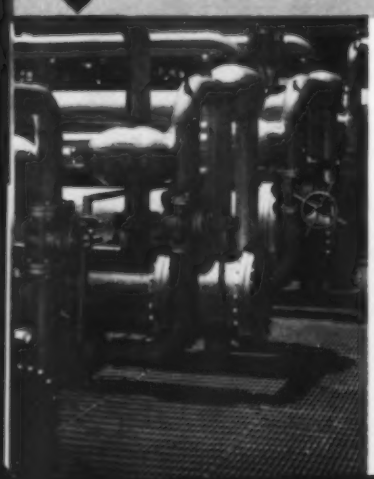
IT'S EASY TO FIT THE RIGHT

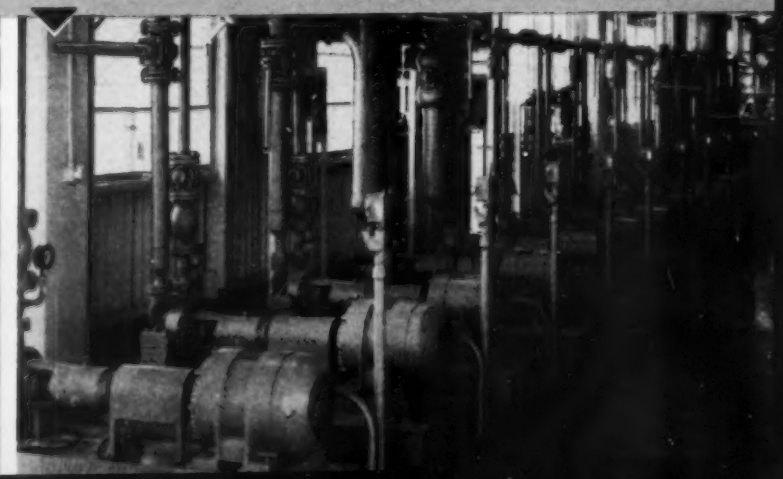


SPECIAL APPLICATIONS Nordstrom experience can tell you what special refinery applications you can successfully make with Nordstrom valves.

INSIDE OR OUT The same characteristics that make Nordstroms the most economical valves for unusual line conditions make them the best bet on inside equipment lines.

ALL SIZES There's a Nordstrom valve in the right size, the right pressure class, the right metals, the right end connection, and the right lubricant for nearly every refinery or gasoline plant service.





VALVE TO

Gasoline Plant and Refinery Services

With the background of several hundred thousand Nordstrom valves in refinery service around the world, Nordstrom engineers can help you select the best, most efficient designs for each type of refinery operation.

Nordstrom valves are especially suitable for refinery lines. The extra seal of plastic lubricant around the seat port area protects seating surfaces against line fluid, and at the same time gives a hydraulic jacking action for easy opening where line conditions cause many valves to stick.

For nearly all complex, hard-to-control refinery line fluids there are suitable Nordstrom valves. These are typical Nordstrom services:

HANDLING HYDROCARBONS—Loading rack, marine terminals, general transfer and run-down lines and other applications throughout the refinery where light hydrocarbons are the line fluid.

CHEMICAL TREATING—Handling treating acids, caustic, Doctor Solution, copper chloride and other reagents, in continuous or batching processes. Special metals are available.

LUBE OIL TREATING—Selective solvent treating of lube oils, including treatment with phenol, etc., along with the deasphalting of oils with propane, methyl ethyl ketone and other methods.

REFINERY GASES—In unit operations or compressor plants, Nordstrom lubricant-sealed valves are generally preferred.

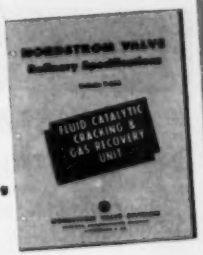
AVIATION GASOLINE PRODUCTION—Manufacture of alkylate for making high octane gasoline, either by the sulphuric acid process or anhydrous hydrofluoric acid process. Special metals, packings and flow area facings are available.

WATER SERVICES—Condenser service, water process lines and power plant lines.

AIR LINES—All types of air service lines.

PETRO-CHEMICAL MANUFACTURE—Examples: phthalic anhydride, isopropyl alcohol, synthetic glycerine, synthetic ethyl alcohol, napthenic acids and other petroleum based chemicals.

Now You Can Easily Fit Nordstrom Valves to the Specific Services in Your Specific Refining Process



So that refinery engineers can select the proper Nordstrom Valves for each service in the principal refining processes, a series of specification sheets showing recommended materials, pressure classes, lubricants and valve figure numbers has been prepared. There is a special Nordstrom Specification Bulletin for each of these processes:

Catalytic Polymerization
Crude Topping and Vacuum Distillation
Cycleversion
Delayed Coking
Distillate Recovery in Cycling Plants
Duo-Sol Solvent Extraction
Fluid Catalytic Cracking and Gas Recovery
Girbotol Process
Houdriflow Catalytic Cracking and Gas Recovery
Hydroforming Process
Light Ends Fractionation
Naphtha Polyforming
Phenol Extraction
Propane Deasphalting
Propane Dewaxing
Selexol Process
Solvent Dewaxing
Thermal Cracking
Thermal Reforming

A Nordstrom service engineer will be glad to review these specification sheets with you. Call your nearest Rockwell office or write to Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

EASY STANDARDIZATION Because Nordstrom builds such a wide range of types and sizes, with wrench, geared or automatic operation, you can standardize on them throughout the refinery or gasoline plant.

There's an oil field supply store with Nordstrom Valves and Nordstrom Service as close as your telephone.

Rockwell Built

Nordstrom Valves

Another Rockwell Product

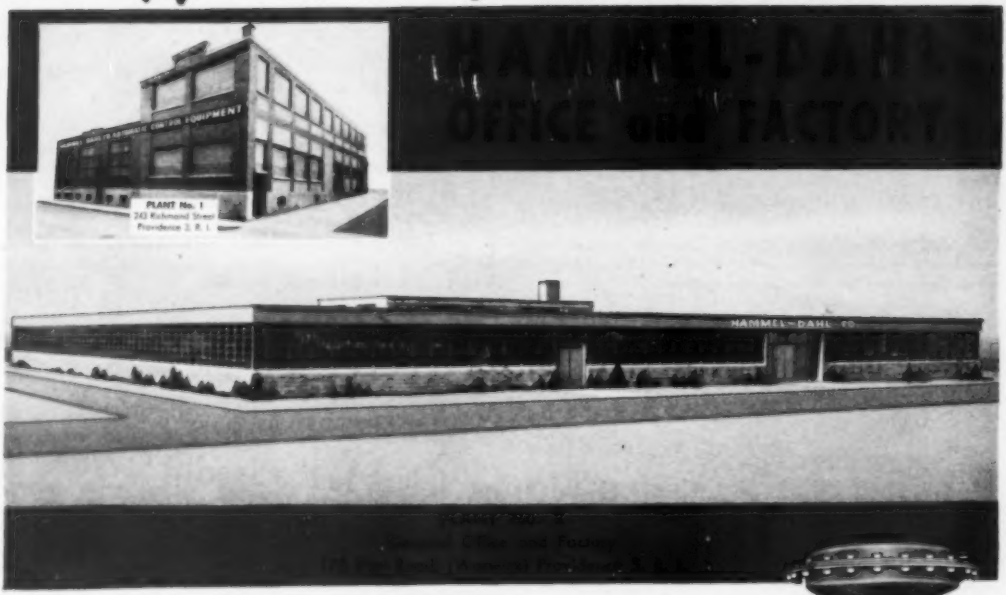
Lubricant Sealed to Keep Upkeep Down

ROCKWELL MANUFACTURING COMPANY
400 N. Lexington Ave., Pittsburgh 8, Pa.

AUTOMATIC CONTROL EQUIPMENT

HAMMEL-DAHL

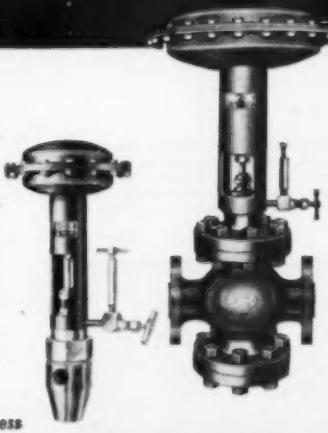
Announcing a 2nd **New and Modern**



OUTSTANDING ENGINEERING AND PRECISION WORKMANSHIP

Constantly increasing demand from ALL of the PROCESS INDUSTRIES for more HAMMEL-DAHL Control Valves, embodying these basic qualities, has made necessary the construction of this new, larger, modern plant. It is equipped throughout with machine tools of the latest design, production equipment, assembly and testing fixtures.

This expansion means faster deliveries, superior service and better attention to each and every customer's requirements.



Consult your nearest H-D Sales Engineer for Precision Control of your Process

HAMMEL-DAHL COMPANY

175 POST ROAD, WARWICK PROVIDENCE 5, R. I., U. S. A.

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San Francisco Seattle Springfield, Mass. St. Louis Syracuse Toledo Tulsa Wilmington, Del.

Introducing!...

GUARANTEED SPRING-KOTE

INSULATES
CONTROLS CONDENSATION
PREVENTS CORROSION
VAPORSEALS
DEADENS SOUND
BEAUTIFIES

On metals or masonry, Spring-Kote protection is unaffected by time, temperature-change, vibration, or exposure to the elements. It seals cracks, joints, and porous building materials; repels water; eliminates need for painting—adheres, indoors and out, to new or old surfaces with a firm and tenacious bond. In the past 17 years, a similar material, known as "Dednox," has been used on some 250,000 freight cars without a single reported failure.

THICK, RESISTANT—CONTAINS NO WATER

Spring-Kote is not an emulsion. Instead, it's a cut-back asphalt with very high content of inert fillers—mica, asbestos, and ceramic clays. It resists acids, acid fumes, hot vapors, impact, and the sun's actinic rays. Having no water, and consequently less shrinkage, it dries quickly into a tough and flexible coating about 50% thicker than does the same applied quantity of asphalt emulsion. Depending upon use, a Spring-Kote coating is from 15 to 50 times thicker than paint.

EASY AND ECONOMICAL TO APPLY

Most plant maintenance departments already have the standard equipment for spray-application on walls, roofs, tanks, ducts, etc., or the work can be done by a local qualified applicator. Spring-Kote is made for vaporsealing; with cork impregnation for insulating; in light pastel shades for residential use. Colored granules are also available for commercial and industrial surface finishing. Thoroughly time-tested and use-proved. Won't sustain combustion. Write for all the money-saving facts about guaranteed Spring-Kote protection.

Ask for New Bulletin No. 101.

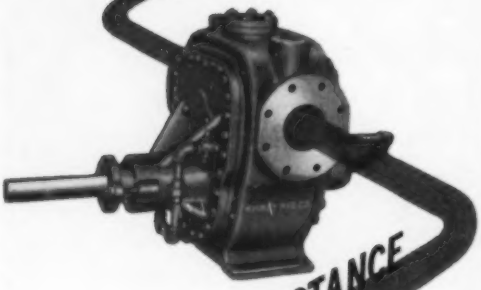
Inquiries from Sales Engineers and Applicators invited.

MR. ESPEY SPRING PACKING CORPORATION

SPRING PACKING CORPORATION

332 South Michigan Avenue, Chicago 4, Illinois

TAKE THIS PATH



OF LEAST RESISTANCE

...the short, unobstructed path through a ...ney SD Rotating Plunger Pump. For handling asphalt and other viscous liquids, this valve-free pump is the simple, sure, economical solution to your pumping problems.

The Kinney SD Pump is specially engineered for this type of work. There are only seven moving parts: 2 cams, 2 rotating plungers, 2 guide pins, and a single shaft. There's only one stuffing box to service. There are no valves, blades, springs, vanes, or gaskets. The two rotating plungers, set 180° apart, provide perfect balance within the pump and assure a smooth, steady flow.

In construction, the SD Pump is extra-heavy . . . extra-dependable. Even on the most rigorous jobs, SD Pumps give years of service with only minimum attention. Send coupon for illustrated Bulletin L51. KINNEY MANUFACTURING COMPANY, Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle, and foreign countries.

Kinney LIQUID PUMPS

KINNEY MANUFACTURING CO.
3596 Washington Street
Boston 30, Mass.

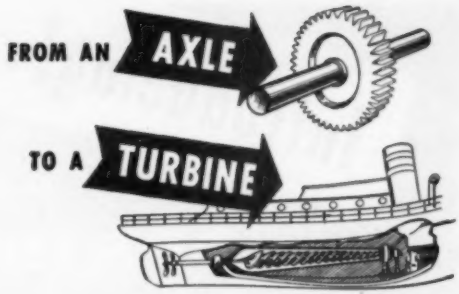
Please send Kinney Liquid Pump Bulletin L51.

Name .....

Company .....

Address .....

City ..... State .....



WHEREVER PETROLEUM IS USED AS LUBRICANT OR FUEL

ADSORBENTS

have helped to prepare it!

From plain axle grease to the most highly refined and specialized motor oils—

From the most common commercial grade of fuel to aviation gasoline of the highest rating—

New sense is given to the old saying that "oil and water don't mix."

Wherever decolorization or dehydration enters into petroleum processing, Floridin products have been approved for forty years.

If you have use for natural adsorbents in any industrial process, these products should be of interest to you.

FLOREX FULLERS EARTH

High-pressure extrusion insures maximum effectiveness.

BAUXITE-BASED ADSORBENTS

Write for full data. The advice of a competent technical staff is offered. Your inquiry will get prompt attention.

FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Dept. E, 220 Liberty St., Warren, Pa.

We applied the "strip-tease" principle to dealer education

Oil company executives who have seen Ethyl's "Product Sales Clinic" say that it gives more real sales-building information than anything of its kind. This new show was developed to help you carry out your dealer-education program. Its purpose is to give service station personnel a working knowledge of engines, fuels, lubricants and TBA items.

As you know, dealer education is at best a difficult and laborious task. Textbooks and pamphlets seldom get careful study, even though they are attractively illustrated and diagramed. And you know how during long meetings even the best of upholstered chairs get hard. Men start to fidget and wish themselves out.

We believe one solution to the dealer-education problem is "showmanship."

(continued on next page)

We applied the "strip-tease" principle to dealer education

(*continued from preceding page*)

So in our Clinic we employ basic theatre techniques, one of which is the "strip-tease" principle. Giant models of an engine, a carburetor and a distributor are stripped down to show the how and why of their operations.

Other interest-holding ideas are an unusual use of black light and fluorescent paints . . . dramatic demonstrations of such subjects as knock and oil contamination . . . and a "talking" engine operated on various fuels while big dials tell the different stories of speed, power and heat.

Several units of the "Product Sales Clinic" are now working full time. And plans are being made to expand this service to meet the demands of the industry.

ETHYL CORPORATION

NEW YORK 17, NEW YORK

Ethyl service is backed by 28 years of antiknock experience

FARM SERVICE

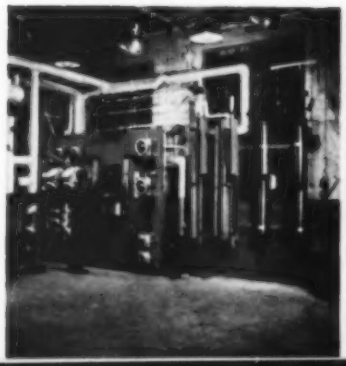
FUEL RESEARCH

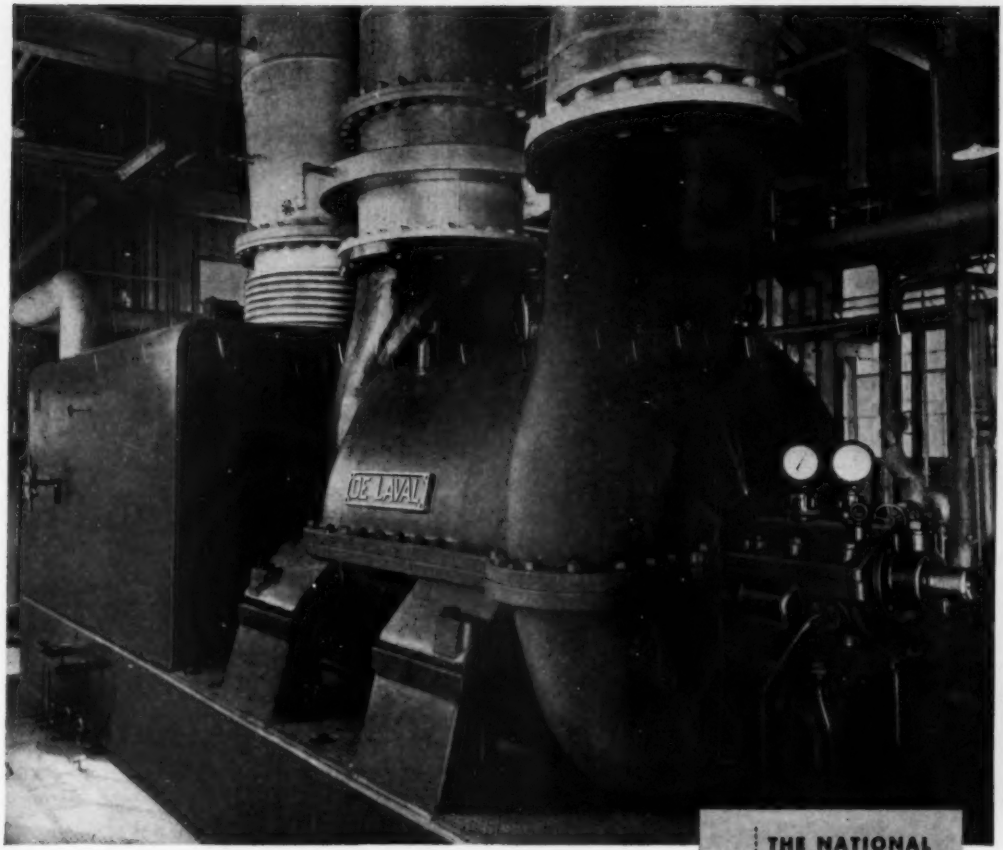
ROAD RATINGS INDOORS

PREMIUM GASOLINE PROMOTION

SAFETY SERVICE

GASOLINE TESTING





This blower never takes a "breather"

at THE NATIONAL COOPERATIVE REFINERY ASSOCIATION

There's no time out for this De Laval turbine-driven blower at the McPherson, Kansas fluid catalytic cracking plant of the National Cooperative Refinery Association. Twenty-four hours a day this 21,500 cfm, 2,270 hp unit handles air for regeneration of the spent catalyst.

There are good reasons for this power-saving dependability. This heavy-duty machine is built to take punishment. Its rugged casings, husky, perfectly balanced rotor and externally mounted, cylindrically seated bearings are design features that reduce maintenance and insure continuous operation for long periods of service. And remember, there's no divided responsibility—both turbine and blower are De Laval designed, and De Laval made.

De Laval blower experience covers a wide range of industries — steel, refining, metal mining, chemical processing, high pressure gas transmission, manufactured gas, sewage aeration and many others. And all this engineering and manufacturing experience is ready to solve your specific blower application. Discuss it with a De Laval representative.

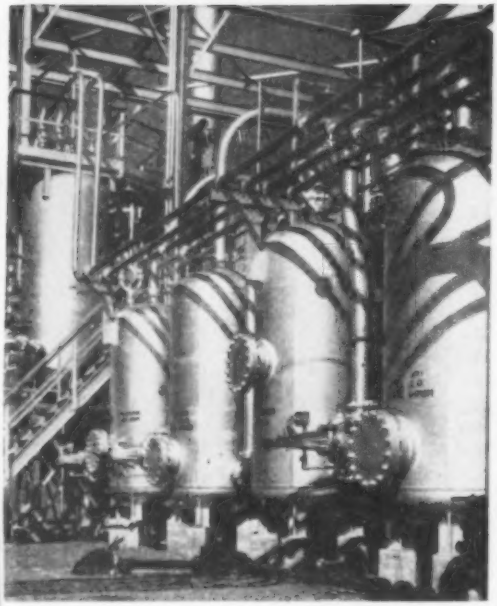
DE LAVAL *Centrifugal Blowers*

Send for Bulletin 0500 containing complete data.

DE LAVAL STEAM TURBINE COMPANY
Trenton 2, New Jersey

DL-189

NEED these Quality Products for Petroleum Processing?



- ✓ SODA ASH
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Want to be certain of quality and uniformity in the chemicals you use for processing operations? Make sure you get them from SOLVAY—America's leading producer of alkalies and associated chemicals! You can also depend on SOLVAY for *service*—for helpful *sales* service from thirteen sales offices and a nationwide chain of distributors; for *delivery service* from centrally-located plants and over 200 coast-to-coast stock points; and for an exclusive Technical Service for the petroleum industry.

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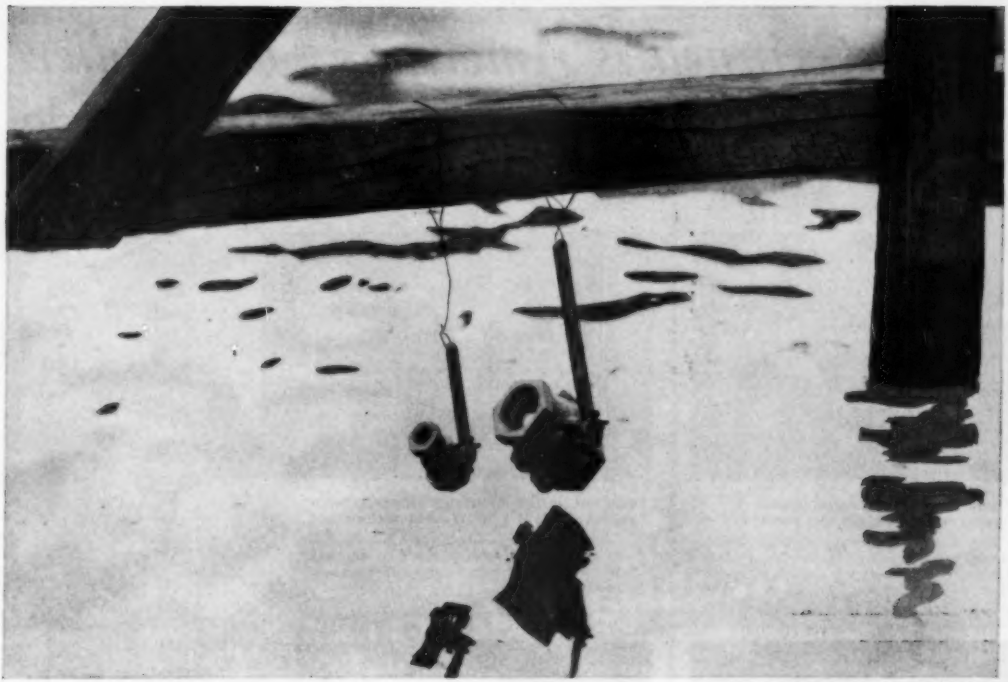


THESE ROCKWOOD BALL VALVES were undamaged after hanging from a Connecticut pier for 3 months.

90-Day Exposure to salt water leaves Rockwood Valves unharmed

The dramatic test for Rockwood Ball Valves, shown above, was conducted by a public official of New Haven, Connecticut.

He suspended a ¾" and a 2" bronze valve from his pier. He hung the valves at the mean tide level so that they were alternately immersed in salt water and exposed to salt air . . . then left them in a partially open position for 3 months.

Result?

After being taken apart, examined, reassembled and retested, both valves were found free from any sign of leakage! *From all appearances they were in no way affected by the severe exposure conditions to which they were subjected.*

WHAT THIS TEST MEANS TO YOU

You, too, can depend on Rockwood Ball Valves not only in lines handling salt water but also in lines handling all types of liquids and gases such as carbon dioxide, nitrogen, paraffin and asphalt base petroleums, alcohol and others. Rockwood Valves are built to stand the gaff.

Available in bronze in pipe sizes from ½" to 2" and in cast steel from 3" to 4". Recommended for 300 psi working pressure.

If you are not now using Rockwood Valves why not write for Bulletin V-4 today? Get complete data including prices and applications.

INDIVIDUAL PARTS of Rockwood Valves are here shown after 90-day water test. Note excellent appearance.

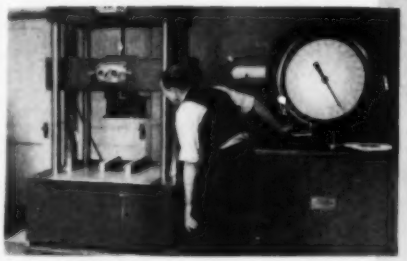
★ Leakproof service
★ Full round flow
★ Quick opening and closing
★ No maintenance

ROCKWOOD SPRINKLER COMPANY
102 HARLOW STREET, WORCESTER 5, MASS.
Distributors in all principal cities

Why Grinnell is America's #1 Supplier of PIPE HANGERS *and* SUPPORTS

GRINNELL, ALONE, MANUFACTURES A FULL LINE OF HANGERS AND SUPPORTS

No other company, anywhere, makes a line as complete or varied. Grinnell produces hangers in thousands of combinations to support any piping.



GRINNELL, ALONE, MAINTAINS AN EXPERIENCED LABORATORY STAFF OF TRAINED TECHNICIANS

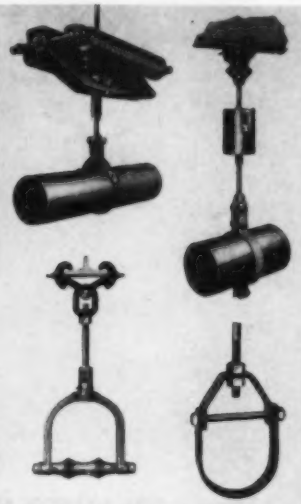
In its modern, well-equipped laboratory, tests are constantly being made to discover better ways of solving old and new pipe suspension problems.

GRINNELL, ALONE, PROVIDES ENGINEERING ASSISTANCE IN DESIGN AND INSTALLATION

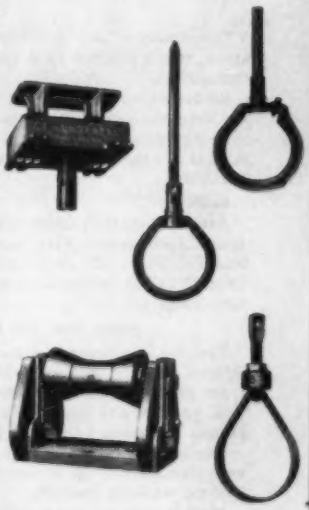
Grinnell makes available specialized knowledge in the computation of hanger loads and the selection of the correct supports. Engineers in the field assist with problems in erection of pipe hangers.

GRINNELL, ALONE, THROUGH ITS CONVENIENT WAREHOUSES CAN SUPPLY YOU "OUT OF STOCK"

No manufacturer of pipe hangers offers a distribution system as thorough or efficient. Grinnell warehouses are located in 30 principal cities . . . with jobbers in practically every city, coast to coast.



Grinnell makes scientifically designed, ruggedly built pipe hangers and supports for every type installation.



Pipe suspension presents an extremely wide range of problems involving weights, stress, thermal movement, materials and specialized engineering. No one "goes into" the pipe hanger business overnight. Large manufacturing facilities, skilled technicians, and a lot of down-to-earth practical experience are needed.

Grinnell has become America's No. 1 supplier of pipe hangers and supports only because Grinnell has specialized in piping for one hundred years. Grinnell has developed a line of pipe hangers and supports for every piping requirement, from the simplest to the most complex.

Grinnell is always ready to co-operate with engineers and architects in the preparation of pipe suspension specifications.

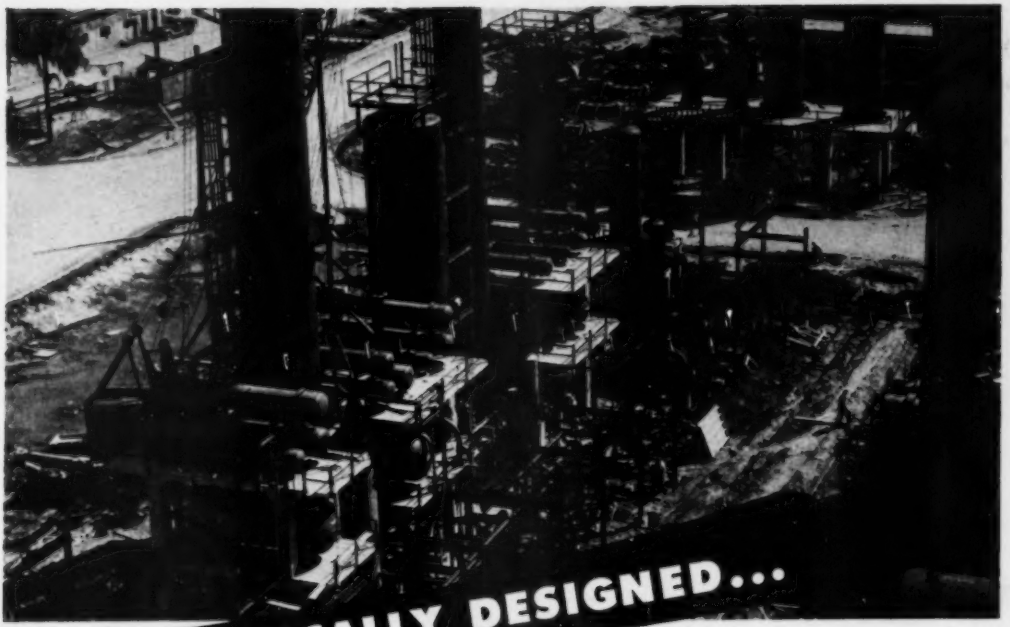
Call Grinnell for any and all types of pipe hangers and supports.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Sales Offices and Warehouses in Principal Cities

pipe and tube fittings • welding fittings • engineered pipe hangers and supports
Thermolier unit heaters • valves • Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies • industrial supplies
Grinnell automatic sprinkler fire protection systems • Amco humidification and cooling systems



SPECIFICALLY DESIGNED...

FOR THE REQUIREMENTS OF THE JOB!

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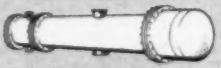
REBOILERS



CONDENSERS

ATMOSPHERIC SECTIONS
(Horizontal and Vertical)

STEAM GENERATORS

JACKET WATER COOLERS

EFCO HEAT TRANSFER EQUIPMENT

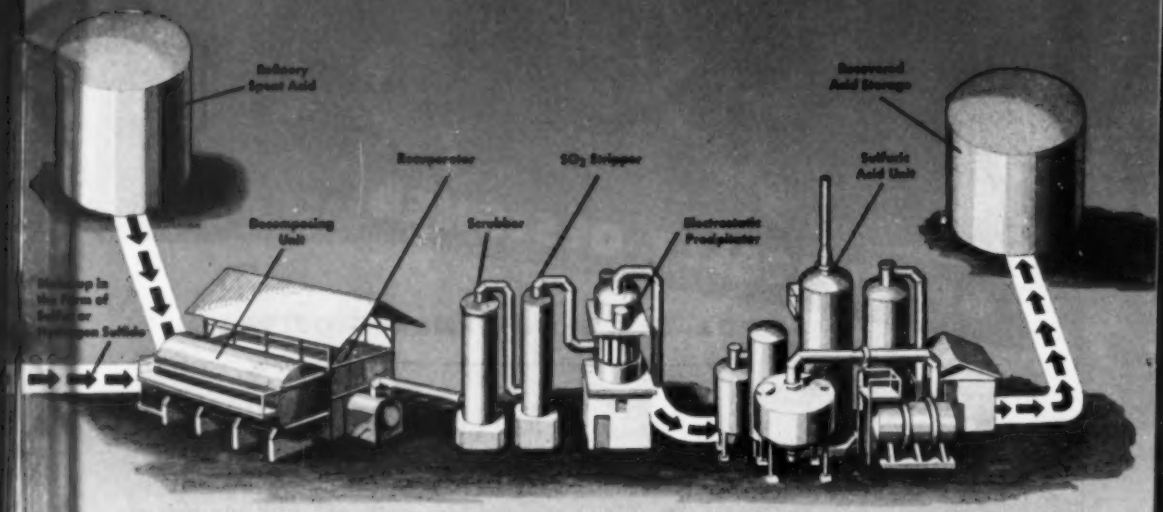
● EFCO engineers can supply you with any type of heat transfer equipment to meet your specifications. Reboilers, condensers, atmospheric sections, jacket water coolers, steam generators and heat exchangers, made by EFCO specialists, are sturdily constructed to give long trouble-free service. Ask an EFCO engineer. He will be glad to help you with your heat transfer problems.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO HEAT TRANSFER EQUIPMENT

CHEMICO OFFERS AN ECONOMICAL PROCESS FOR

Spent Alkylation Acid Regeneration



*D*ue to the increased cost of brimstone and the vital need to conserve basic sulfur deposits, petroleum refiners producing high octane aviation gasoline will find it desirable to recover the sulfuric acid from their spent alkylation acid. For this purpose, Chemico offers a proven and economical process.

In this process, spent alkylation acid—now in greater supply as a result of the increased manufacture of high octane gasoline—is sprayed into a furnace maintained at a high heat with auxiliary burners. Sulfur or hydrogen sulfide may be used as fuel thereby producing SO_2 gas for the production of make-up acid.

A limited amount of other liquid acid sludges, high in hydrocarbon content, may also be added to the alkylation spent acid, thus providing fuel as well as additional acid production. The hydrocarbons are completely consumed and the acid is broken down into its components—sulfur dioxide, oxygen and water. After the water is removed, the gas is processed to fresh acid of 98% strength in a Chemico contact sulfuric acid unit. Send for additional information, stating your requirements.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
CABLES: CHEMICONST, NEW YORK

Chemico plants are profitable investments

CC 311

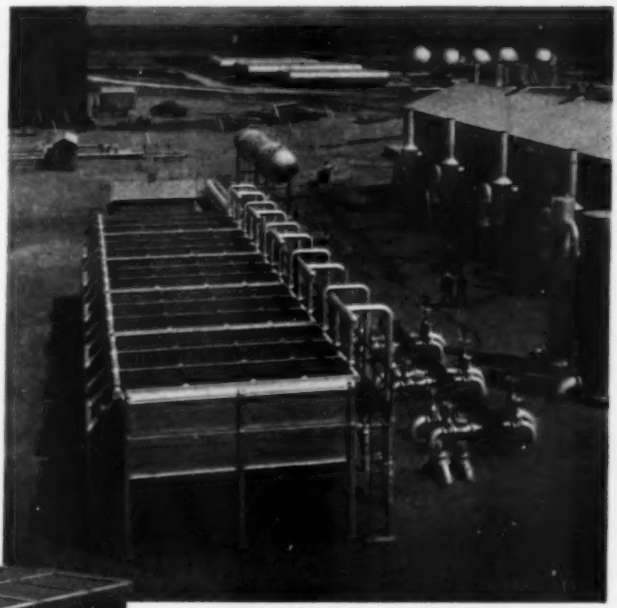
Gilbarco
ALLOY BUBBLE TRAYS
For sectional alloy bubble trays and other fractionating tower internals that are easier and faster to install—look to Gilbarco.
New designs which make for greater strength and rigidity with lighter weight—in addition to faster assembly—are widely adaptable to all process requirements. The same features which lower both initial and installation costs also cut turn-around time.
With eighty-seven years of manufacturing experience, twenty-one acres of factory facilities and a large engineering staff, Gilbarco stands able and eager to fulfill the most exacting requirements of your process designers. May we send you complete information?
GILBERT & BARKER MANUFACTURING COMPANY
WEST SPRINGFIELD, MASS.
Copper trays for a major chemical company are shown in this photo.

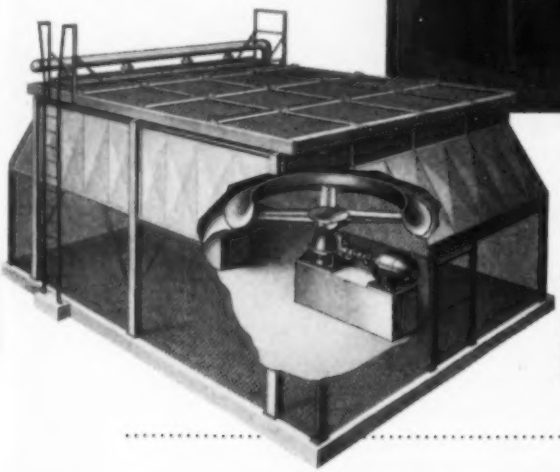
make your own comparison...

a Fluor-GR Fin-Fan

against any other air-cooled heat exchanger

When considering air-cooled heat exchanger equipment, compare the advantages of a Fluor-GR Fin-Fan. Make comparisons of structural simplicity and flexibility. Compare the exclusive features of the Griscom-Russell K-Fin section, the rugged yet precision design of Fluor mechanical equipment. Check *proven performance* in such varied services as gas transmission systems, petroleum refineries, light hydrocarbon processing plants, chemical processing plants, and power and industrial plants. Before you buy or specify, compare the Fluor-GR Fin-Fan. A Fin-Fan provides more exclusive design features —features that add up to *efficient, dependable* performance—than any other make of air-cooled heat exchanger. Write for Fluor Bulletin No. FF-8501.





Compare

structural design

Structurally, the Fin-Fan is the ultimate in simplicity and flexibility. Its "truss-type" design provides a rugged, vibrationless unit, free of extraneous parts. Uniform prefabrication of parts, with bolt holes and orientation incorporated in basic design, permits easy extension without shut-down of existing units!

Compare

K-Fin features

G-R K-Fins are tension-wound for moderate temperatures, rolled into grooves for elevated temperatures. Threaded header plugs provide quick, easy access to tube ends for cleaning or replacement. Plugs are shoulder-tight to form a leakproof metal-to-metal joint at all pressures, independent of thread tightness.

FLUOR

Engineers - Constructors - Manufacturers

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
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Represented in the Sterling areas by:
Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

Compare

mechanical equipment

Fluor mechanical equipment is ruggedly designed to meet specific heat transfer requirements. 4 basic gear units cover 4 different and distinct horsepower ranges. This, coupled with a choice of fan assemblies ranging from 8' to 20' in diameter, with 4 or 6 blades per fan unit, enables the proper combination of gears and fans to effect optimum efficiency.

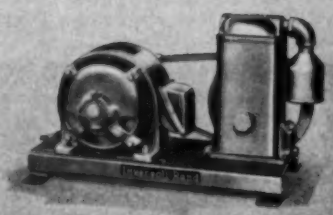
Compare

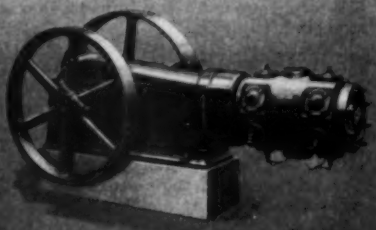
proven performance

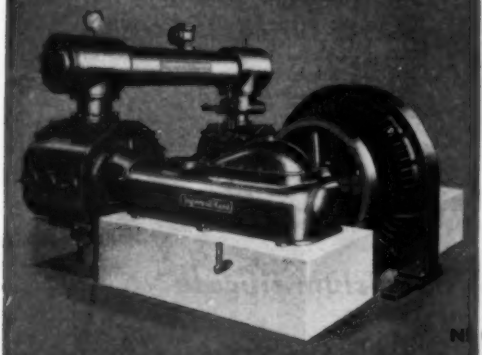
More Fluor-GR Fin-Fan Air-Cooled Heat Exchangers are in service throughout the continental United States and in countries abroad than any other make. More Fluor-GR Fin-Fan installations are the result of repeat orders than any other type. Check with your nearest Fluor Representative for the Fin-Fan's outstanding record of proven performance—in services and duties similar to your own!

Oil Free Air for your Instruments

INGERSOLL-RAND HAS NL COMPRESSORS FROM THE SMALLEST TO THE LARGEST







Air-operated instruments, like production tools, are vitally important. That's why so many plants are using Ingersoll-Rand NL air compressors, that *don't pump oil*. This guards against instrument failures caused by oil-laden air.

Non-lubricated compressors, pioneered by I-R, feature pistons fitted with graphitic-carbon rings that prevent metallic contact of the piston with the cylinder bore. These carbon rings are segmental with metallic inner expanding rings, to give the proper wall pressure. Because metallic contact is eliminated, and the rings are self-lubricating, the Ingersoll-Rand NL Compressor cylinders require no lubricant.

To really put an end to production delays and excessive maintenance costs caused by oil-clogged instruments, get all the engineering facts and figures I-R makes available. Simply contact your nearest I-R representative, or write direct to Ingersoll-Rand, 11 Broadway, New York 4, New York.

Model N machines available through 1 hp.

Model 235 HNL machines available through 3 hp—other models through 250 hp.

Ingersoll-Rand

717-3

NL Compressors . . . 70 years of compressor "know-how" packed into these new compressors for air operated instruments!

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

Does Your Present Heat Insulation Have All These Advantages?

Kaylo Heat Insulation is a hydrous calcium silicate—a revolutionary heat-saving material—outstanding both in performance and ease of application.

KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters for snug nesting, when necessary.

1 **LOW "K" FACTOR**—Billions of sub-microscopic air spaces which compose the structure of Kaylo Heat Insulation give it exceptional insulating value.

2 **TEMPERATURE RANGE UP TO 1200° F.**—Kaylo Heat Insulation eliminates the need for combination coverings in nearly all operating conditions.

3 **LONG SERVICE LIFE**—Kaylo Heat Insulation remains dimensionally stable, strong and efficient over the years—although exposed to temperatures up to 1200°F.

4 **INSOLUBILITY IN WATER**—Even when saturated, Kaylo Heat Insulation retains about 85% of its strength. It returns to its original strength after drying.

5 **HIGH STRENGTH**—Breakage of Kaylo Heat Insulation is almost negligible in shipping and installation—workmen can walk on insulated equipment without causing breakage.

6 **LIGHT WEIGHT**—Since Kaylo Heat Insulation weighs only 11 pounds per cubic foot, it is exceptionally easy to handle and apply.

7 **WIDE RANGE OF SIZES AND SHAPES**—Kaylo Heat Insulation's unmatched selection of sizes and shapes reduces the number of pieces required per job.

8 **EASE OF CUTTING AND FITTING**—Ordinary tools of the trade are used to install Kaylo Heat Insulation. The material is non-irritating to the skin and non-toxic.

For complete details on all of the advantages of Kaylo Heat Insulation, write Dept. N-237, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

SEE OUR CATALOG IN THE REFINERY CATALOG

KAYLO® ... *first in calcium silicate*

...*pioneered by* OWENS-ILLINOIS Glass Company

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DETROIT • HOUSTON • MINNEAPOLIS • NEW YORK • OKLAHOMA CITY • PHILADELPHIA • PITTSBURGH • ST. LOUIS • WASHINGTON

EQUIPMENT WITH ENGINEERING SERVICE

This is the largest of a new type of field installation for the conservation of natural gas, furnished by Maintenance Engineering Corporation. It is a completely unitized and automatic system for pressure maintenance of oil reservoirs.

COMMERCIAL
Orifice Fitting

HAGAN
Ring Balance Meter

MASONEILAN
Control Valve

MASONEILAN
Pressure Controller

PEERLESS
Injection Well Separator

SMITH
Positive Displacement
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MAINTENANCE
ENGINEERING CORPORATION
3611 CLINTON DRIVE L.D. 409 PR. 3135
P. O. BOX 2637
HOUSTON 1, TEXAS

MECO

Our case history files will help you solve any refinery tubing problem

● If you buy refinery tubing, you probably know quite a bit about steel analyses already. But it's hard to keep track of *every* steel tubing analysis, and just how it stands up under the countless combinations of heat, pressure and corrosive materials.

As the world's largest manufacturer of tubular products, we have a file of authentic case histories that covers many of the refinery tubing problems you will encounter. A problem that is new to you may be old to us. We may have encountered it before and solved it with one of our 23 different steel tubing analyses.

You can really use this information today, when so many grades of steel are in short supply. We'll help you select alternates that may do as good a job—sometimes at a lower cost than before.

Save valuable time by checking with us first when you are going to select tubing. There's no obligation, and we'll be glad to give you all the help we can. Write to National Tube Division, United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

23 Steel Tubing Analyses

let us help you select the best for your job

Low Carbon	5 Cr, ½ Mo	17 Cr
Low Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	27 Cr
½ Cr, ½ Mo	5 Cr, ½ Mo, Ti	18-8
1¼ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
2 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2¼ Cr, 1 Mo	8 Cr, 1 Mo	18-8 Mo
2½ Cr, ½ Mo, ¾ Si	9 Cr, 1 Mo	25-20
3 Cr, 1 Mo	12 Cr, Al	

All National Seamless Tubing is pierced from a solid billet of high-quality steel. This is the one manufacturing method that removes all doubt concerning uniform wall strength.

NATIONAL TUBE DIVISION, UNITED STATES STEEL COMPANY, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U-S-S National Seamless Pipe and Tubes

UNITED STATES STEEL

BUILDING A GREATER AMERICA

Advance Guard

OR LOOKING AHEAD

Officially, there's no "Travel Bureau" to plan for the safety and comfort of "passengers" like fractionating towers, but Sun Ship workers must plan routes with expert care.

The man who built, in his cellar, a boat too big to go out the window, just didn't look ahead.

The industry that builds a fractionating tower more than 126 feet in length . . . 12 feet inside diameter . . . and weighing more than 180 tons . . . just has to know how to meet the problems of delivering it. Every problem that might be met along hundreds of miles of railway has to be known and planned for.

Knowing clearances and curves, on every foot of railway routes is part of the job. Planning to meet and master those problems, or to select routes which eliminate them, is part of Sun Ship's job when it builds chemical and refinery equipment.

The Sun-built refineries and chemical equipment serving in every part of America and in many foreign lands shows how well Sun men and management have mastered the problems of delivering the equipment they have produced in helping build a greater America.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

8-hour job now takes 4 hours

At a western magnesium reduction plant something besides magnesium has just been reduced. The steam at the end of the 1½ mile long steam line wasn't so hot—and neither was the production record of the plant at that location.

Then 26 old-type steam traps were replaced with Yarway Impulse Traps. Now there is only a 15° temperature drop from the boilers to the end of the line. *Most important, the plant 1½ miles from the boilers is now able to do work in 4 hours that previously took 8 hours.*

That's trap efficiency! It's evidence of the fact that Yarways are designed to send the most premium B.T.U.'s at top temperatures into your process or product. *They get equipment hotter, sooner . . . and keep it hot.*

Other Yarway features—small size, one moving part, easy installation, low maintenance, low cost, stainless steel construction. Nearly 750,000 Yarways have already been installed. For your Yarways, see a nearby industrial distributor . . . 216 stock and sell Yarways.

YARNALL-WARING COMPANY, 128 Mermaid Ave., Philadelphia 18, Pa.

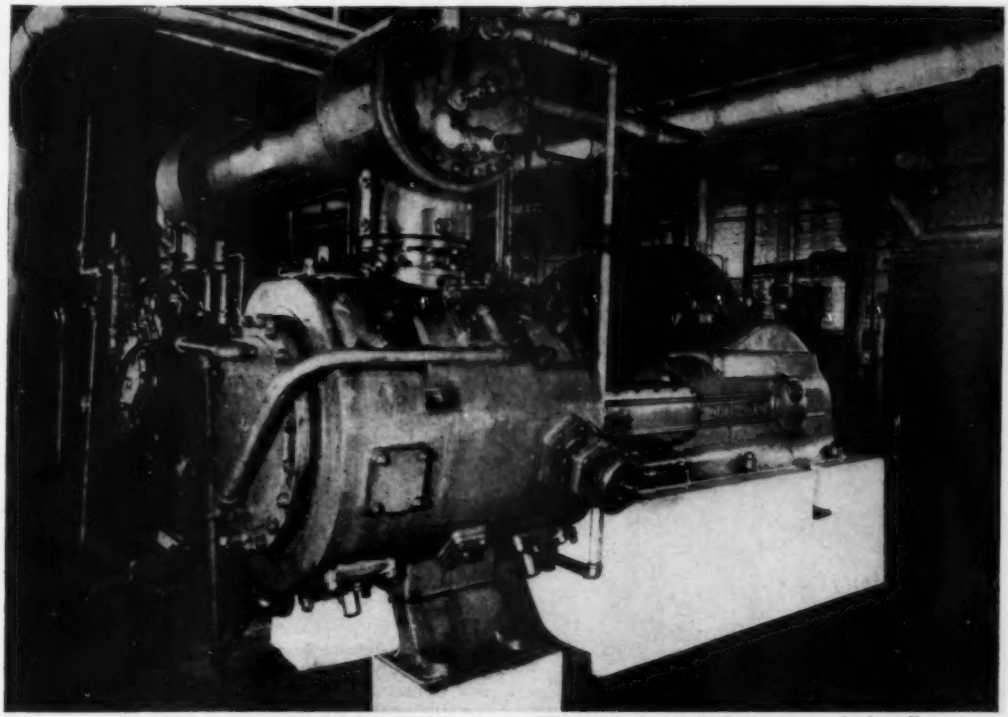
FREE TRAP SELECTOR

It's important to have the right trap *in* the right place. New 20-page selector tells quickly and easily which *is* the right Yarway trap for any application. Write for your free copy.

YARWAY

the steam trap

designed with more production in mind



ONE OF FOUR WORTHINGTON GAS COMPRESSORS in the gas distribution system of a large Eastern gas company. Compressor is positive displacement reciprocating type with capacity of 125,000 standard cu ft of manufactured gas per hour. Maximum discharge pressure is 100 psi. Volume is controlled by Worthington's automatic variable capacity control.

When a large Eastern gas company needed another gas compressor...

... There was no question about which make should be selected!

The gas compressor in the picture had been working so well since 1949 that Worthington was the logical choice for the *next* new compressor to handle expanded capacity.

These Worthington features constantly increase the number of such choices:

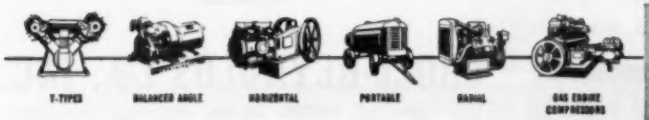
Accurate control of volume that is always assured with Worthington's automatic variable capacity control — acknowledged most accurate, flexible and simple control obtainable.

Worthington's exclusive Feather Valve* — simplest, lightest, most efficient ever made—eliminates valve problems. And Worthington's high-efficiency intercooler needs less water, less power, less attention.

Somewhere in the broad line of Worthington compressors, for air, gas or other "compressables", there is the one right type and size for your job. *Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, N.Y.*

*Reg. U. S. Pat. Off.

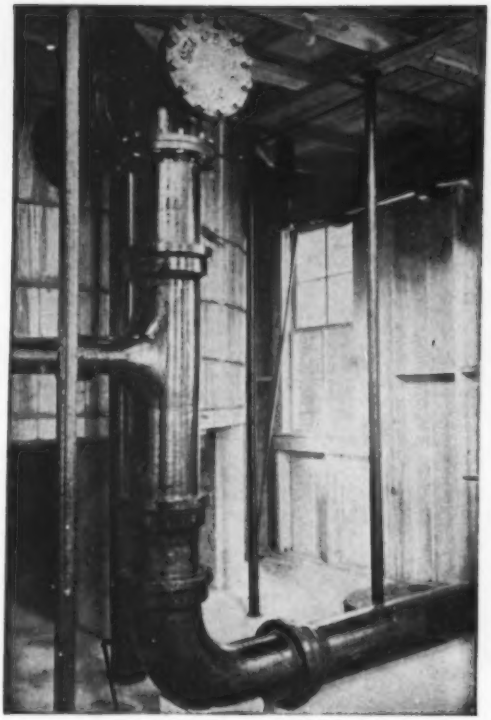
K.2.15



No Other Compressor Will Outperform a Worthington

WORTHINGTON

Compressors



DIRECT ROUTE TO LOWER PLANT MAINTENANCE

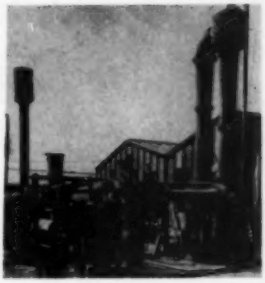
The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

A relatively low first-cost material, cast iron pipe is usually cheapest in the end, for many refinery applications, because of its stubborn resistance to corrosion. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints.

Cast Iron Pipe Research Association,
Thomas F. Wolfe, Engineer,
1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

STRATOSPHERE PRESSURES DUPLICATED



U. S. Government Research maintains a wind tunnel at the University of California for testing parts of airplanes and rockets. In this tunnel, altitudes up to 75 miles in the stratosphere are duplicated by a five stage Evactor, a steam jet vacuum-producing unit designed and built by Croll-Reynolds to work in the range of a few microns of mercury absolute.

Croll-Reynolds five stage Evactors are built in various sizes, the smallest of which handles many times the volume of the largest mechanical vacuum pump. The same careful work and precision which produced these five stage units goes into every other C-R Evactor from the one stager yielding a pressure of four or five inches of mercury absolute to the four stage unit designed for work in the range of 0.15 to 3.0 mm. of mercury absolute.

Many thousands of Croll-Reynolds Evactors are in regular operation, some of them for over 30 years. They are installed in every state of the U. S. and in many foreign countries. Let our technical staff help you with your vacuum problems, including flash cooling of water and aqueous solutions.

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CROLL-REYNOLDS CO., INC.

Main Office: 751 CENTRAL AVENUE, WESTFIELD, NEW JERSEY
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Chill-Vactors · Steam Jet Evactors · Condensing Equipment

Cut CONTROL VALVE MAINTENANCE COSTS!

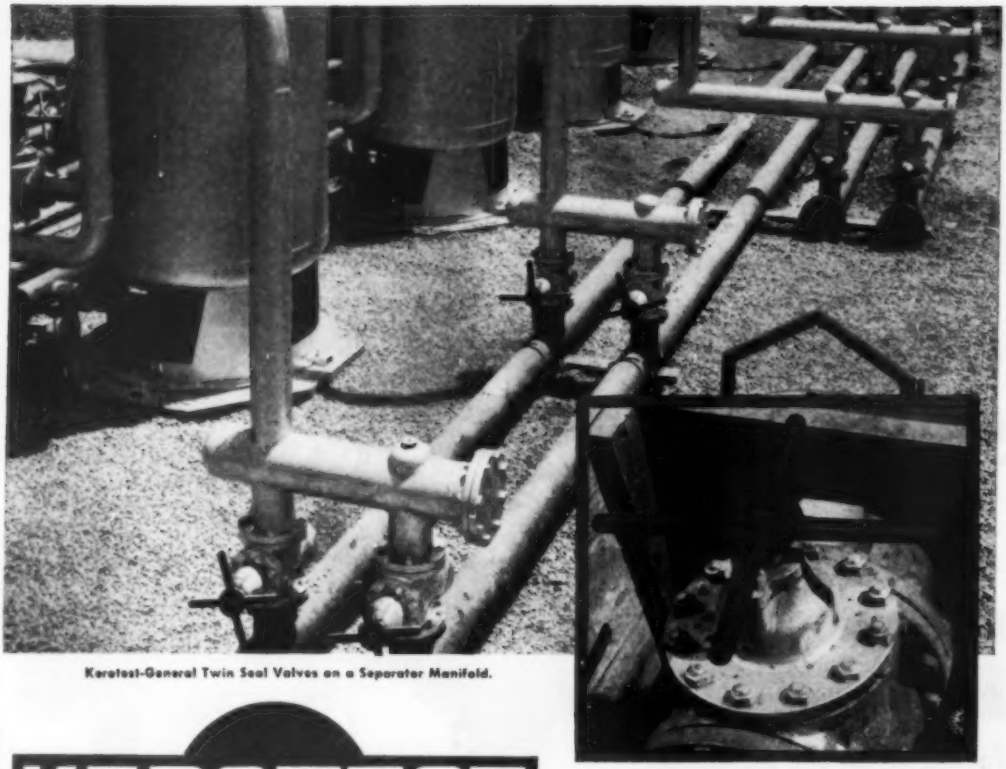
For inspection and maintenance Annin Valves remain in the line

The single seat design of the Annin valve body means lower maintenance costs. As shown, the lower half separates from the valve assembly, exposing for inspection or replacement the valve seat, plug and stem—without removing valve from line. No special pipeline crews are necessary. On-the-job inspection and maintenance by plant crews is practical and economical. Valve seat is not threaded and can be replaced without special tools or grinding-in operations. Under severe erosive and corrosive conditions lower half can be easily replaced at small cost compared to total valve investment. This cost-cutting feature applies to *all* Annin Valves—Domotor, Solenoid, and Handwheel types. All give the ultimate in precision *positive* control. If you are interested in lower maintenance, *and* operating advantages approached by *no other valve*—it will pay you to investigate Annin Valves.

The Annin Domotor valves provide positive control of corrosive, erosive fluids and fluids containing semi-solids.

Send for Annin General Catalog 1500B. Explains the exclusive Annin positive control Domotor action. Contains valuable cost-cutting hints, control valve application facts, flow formulas.

ANNIN CONTROL VALVES



Kerotest-General Twin Seal Valves on a Separator Manifold.

KEROTEST
GENERAL

NON-LUBRICATED
TWIN SEAL
VALVES

- ✓ Shuts off Vapor-Tight
- ✓ Easy to Operate
- ✓ No Lubrication
- ✓ Quick Operation
- ✓ No Scoring or Galling

TYPICAL USES

PROPANE	NATURAL GAS
BUTANE	LIGHT HYDROCARBONS
GASOLINE	LIQUID NITROGEN
LIQUID OXYGEN	CARBON DIOXIDE
CRUDE OIL	COMPRESSED AIR

The Kerotest-General Twin Seal Valve is recommended for gas and liquid service in a pressure range up to 5000 psi at 200° F. Seats shut off vapor-tight—no galling or scoring. Operates *without lubrication.* Special trims are supplied for corrosive service.

WRITE for descriptive bulletin giving full specifications.

KEROTEST MANUFACTURING COMPANY

ENDURO Helps You Stay On the High Side of "95%"

"On stream" 95% of the time . . . and better! That's the magnificent operating record generally being maintained in the refining industry.

Holding that 95% minimum utilization factor requires constant checking on "state of plant"... fast "turn arounds". . . and trouble-free equipment, such as can be made from Republic ENDURO Stainless and Heat-Resisting Steels.

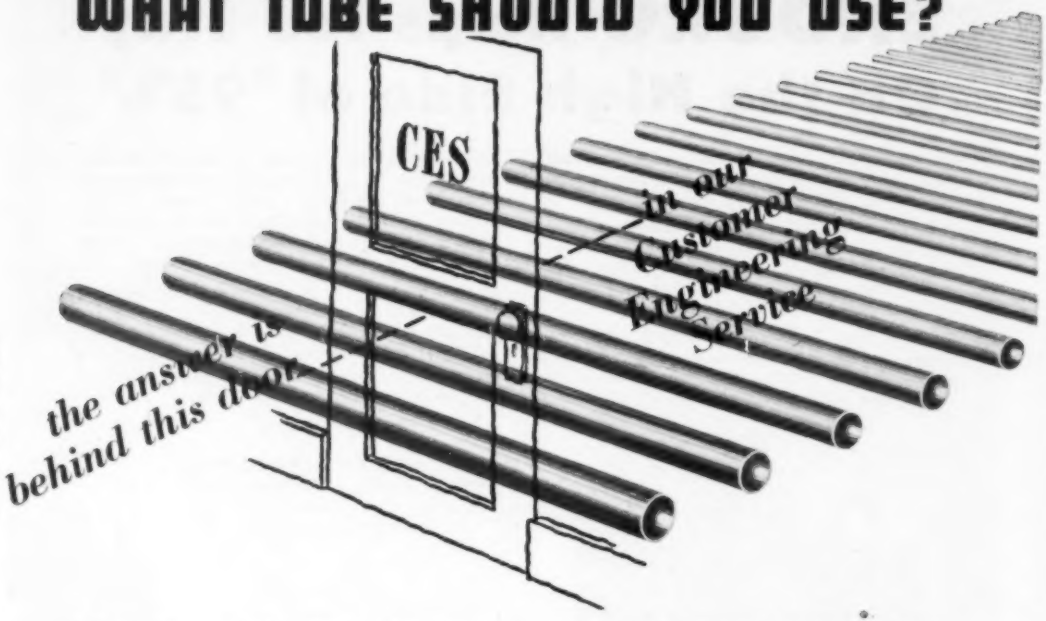
Strong, tough, long-lasting ENDURO stubbornly resists rust and corrosion, as well as the action of most acids and alkalies. Its hard, smooth surface discourages coking and fouling . . . is easy to wash down quickly during "off stream" periods. It maintains its great strength under prolonged exposure to "heavy-end" heat or to sub-zero cold. Because its strength-to-weight ratio is unusually high, it refuses to buckle under pressure . . . even when used in thinner, bulk-saving sections.

In your planning for new and for expanded plant facilities, think ENDURO. Several analyses are available *now* to help you stay on the high side of "95%"—and, Republic always is ready to work with you on any *future* development involving the use of stainless steel. Just write:

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Dept.: Chrysler Building, New York 17, N. Y.

Other Republic Products include Upson Bolts, Studs, Nuts and Rivets—Pipe—Sheets—Plates—Electrunite Heat Exchanger Tubes

WHAT TUBE SHOULD YOU USE?



A tube of a certain alloy will "take it" better than a tube of a different alloy.

And these days — when you are vitally interested in keeping your condensers operating at full efficiency as long as possible — you must be absolutely certain that the tubes in those condensers are most suitable for the material they must handle.

Be sure that they are made of the alloy that is most immune to the corrosive action of the liquid or gas the tubes will carry and therefore give you the longest uninterrupted service.

Whether it's a question of proper alloys — the best wall thickness of tube to use — or a question of the relative values of plain tube against finned tube — you'll find the answer here at Wolverine's Customer Engineering Service.

We suggest that you draw on the wealth of specialized experience that is here at your command without obligation.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
INCORPORATED
Manufacturers of seamless, nonferrous tubing
1431 CENTRAL AVENUE, DETROIT 9, MICHIGAN

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
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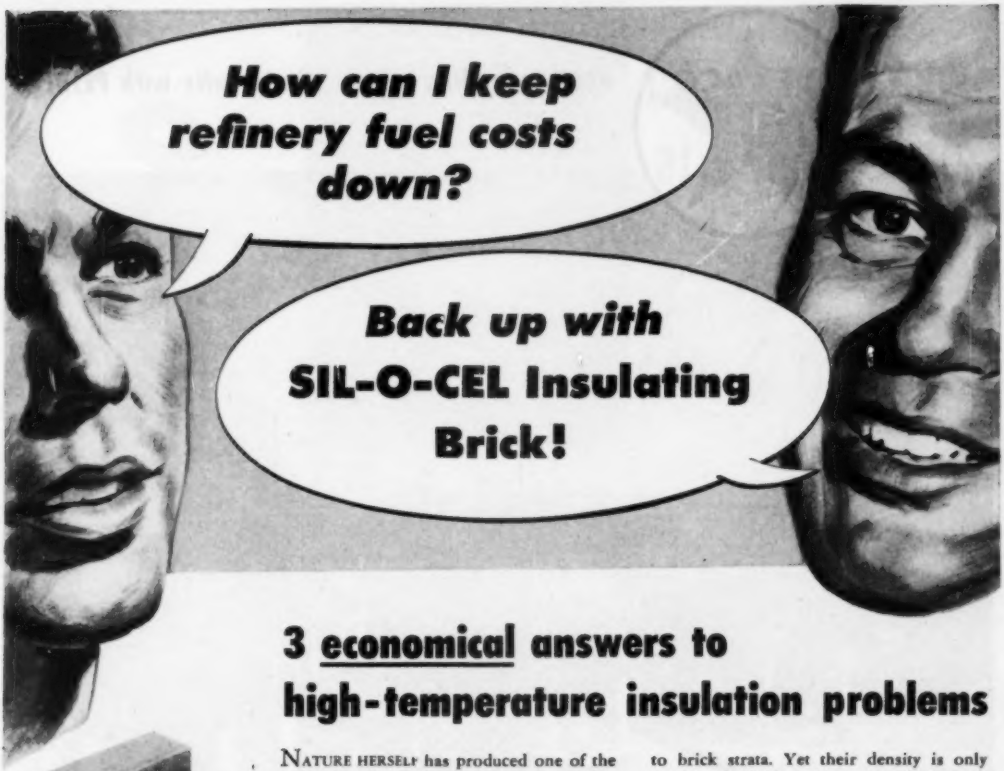
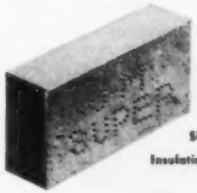


3 economical answers to high-temperature insulation problems

Sil-O-Cel Natural Insulating Brick

Sil-O-Cel C-22 Insulating Brick


Sil-O-Cel Super Insulating Brick

NATURE HERSELF has produced one of the most effective high-temperature insulating materials ever discovered—diatomaceous silica, from which Sil-O-Cel® Insulating Brick are made.

These insulating brick are used for back-up insulation behind fire brick or insulating fire brick linings in boilers, stills, stacks, reactor chambers, regenerators, heaters, flues, retorts, and other types of high-temperature equipment.

Sil-O-Cel Insulating Brick have excellent insulating qualities combined with high load-bearing characteristics and light weight.

Made in all standard shapes of the 2½ in. and 3 in. series, Sil-O-Cel Insulating Brick are produced in three basic types:

SIL-O-CEL NATURAL INSULATING BRICK
for temperatures to 1600F

Quarried directly from one of the world's purest deposits of diatomaceous silica, these insulating brick have a conductivity of only 0.79 Btu in./sq ft/F/hr at 1000F mean temperature, with heat flow perpendicular to brick strata. Yet their density is only 30 lb/cu ft. Cold crushing strength, 400 psi.

SIL-O-CEL C-22 INSULATING BRICK
for temperatures to 2000F

Ideal where high load-bearing properties are needed, this type of Sil-O-Cel is calcined, and has a cold crushing strength of 700 psi. Conductivity is 1.88 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 38 lb/cu ft.

SIL-O-CEL SUPER INSULATING BRICK
for temperatures to 2500F

A calcined insulating brick for unusually high temperatures. In many cases, it is also possible to save on construction costs by reducing the thickness of fire brick or insulating fire brick when backed with Sil-O-Cel Super Insulating Brick. Conductivity is 1.95 Btu in./sq ft/F/hr at 1000F mean temperature. Density, 40 lb./cu. ft. Cold crushing strength, 300 psi.

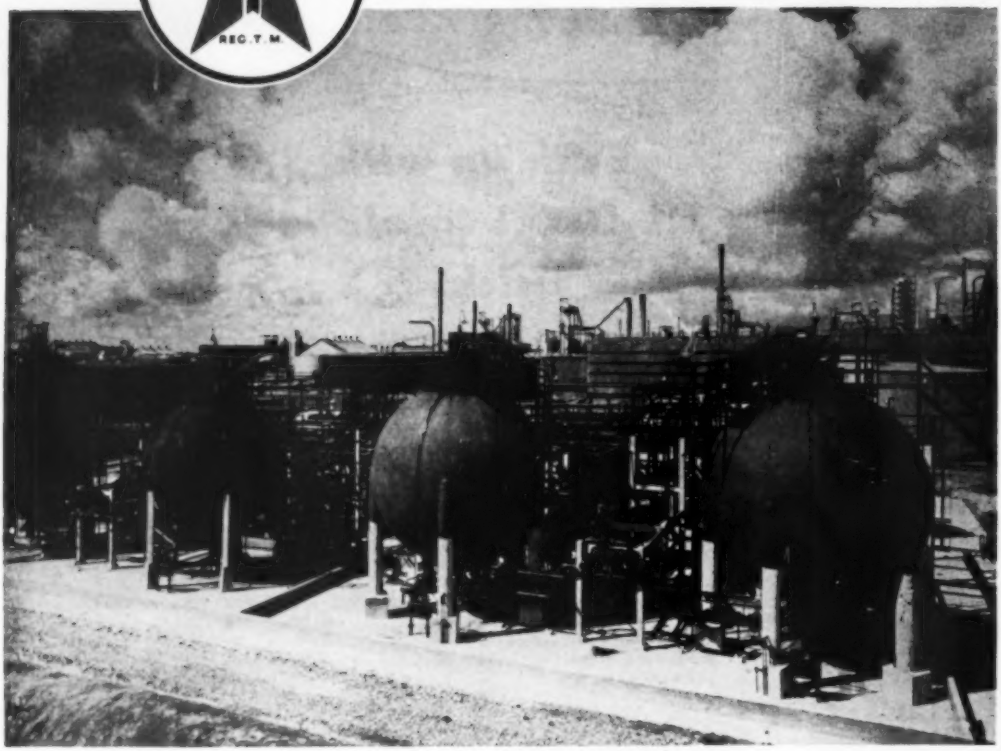
For further information, write to Johns-Manville, Box 290, New York, N. Y. In Canada, write 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first in* **INSULATIONS**

TEXACO
REG. T. M.

another leading refiner who desalts with PETRECO



Illustrated above is one of the largest batteries of Petreco Electrospheres in the world. This installation is located at the Port Arthur, Texas, refinery of The Texas Company. In refinery after refinery, Petreco Desalters have proved their pay-out by increasing on stream time, increasing expected unit throughputs and by reducing maintenance and repair costs. These advantages derived from charging desalted crudes also entail benefits such as reduced furnace plugging, longer tube life, maximum exchanger efficiency, less corrosion in the topping section, clear water bleed, salvaged waste oil and trouble-free, automatic desalter operation. For the best in desalting performance and service, get Petreco.

PETROLITE CORPORATION, LTD. | 2202 South Wayside Drive, Houston 3, Texas
PETRECO DIVISION | 1390 East Burnett Street, Long Beach 6, Calif.

PETRECO OFFERS COMPLETE DESALTING SERVICE AND FACILITIES

PETRECO

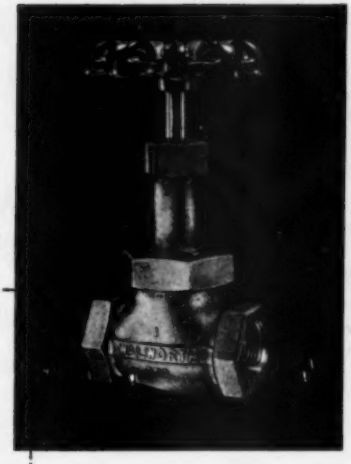
SPECIALIZED Electric PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 51-4

IDENTIFICATION DISC: An aluminum marking plate on all Walworth No. 225P's facilitates inventory control and makes reordering quick and positive.

NEWLY DESIGNED HANDWHEEL: Patented air-cooled, finger-fit handwheel affords sure grip even with greasy gloves.

IMPROVED PACKING: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure when fully opened.



take a good look at the Walworth "500 Brinell" no. 225P Globe

– the Toughest Bronze Valve Your Money Can Buy

The stainless steel, corrosion resistant seats and discs are heat treated to a hardness of 500 Brinell – hard enough to scratch glass and crush nails! The valve can be closed on sand, slag, and pipe scale without injury to the seating surfaces. "Wire drawing" is practically eliminated. All parts are accurately machined and gaged. Years of tight, positive shut-off are assured.

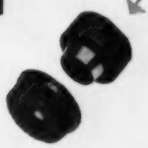
Available in both globe and angle types (angle type: No. 227 P) in sizes ¼" to 2", this quality valve is recommended for 350 lbs. W.S.P. at 550 F, and 1000 lbs. non-shock service on cold water, oil, gas, or air.

For full data on this long-life, economical Walworth Bronze Valve, see your local Walworth distributor, or write for Circular.

note these 7 Great Features

HEXAGONAL UNION BONNET CONNECTION, DEEP STUFFING BOX AND RUGGED STUFFING NUT: Union bonnet connection eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and reassembled.

OVERSIZE STEM: The high-tensile strength silicon-bronze stem assures long life and protection against wear.



SEATS AND DISCS: Plug type seats and discs of stainless steel, heat-treated to 500 Brinell hardness and machined simultaneously to a mirror-like finish, with accurate tapers assures tight positive shut-off with minimum handwheel effort.

EXTRA STRONG BODY: Made of Composition M (ASTM B61) bronze. Thick walls and rugged hexes provide a high safety factor. Valves undergo hydrostatic shell test of 1,000 psi.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

TWO TERRY TURBINES IN RECORD NON-STOP RUN AT CITIES SERVICE

After 26 Months of Continuous Operation, Cost of Replacement Parts Only $78.00 for Each Turbine

Two Terry turbines recently completed a record non-stop run at the East Chicago refinery of Cities Service Oil Company. Specially designed for driving air blowers on fluid catalytic cracking, they ran continuously *from initial start up*, day and night, for two years and two months. Throughout the entire run neither turbine suffered any noticeable reduction in efficiency.

On inspection, after shutdown, it was found that the only parts showing signs of wear were the shaft packing rings. These were replaced at a total cost of $78.00 for each turbine.

While this extremely low cost for repairs, after such a record run, could not have been anticipated, Cities Service had good reason to expect outstanding performance from Terry turbines. A four-year record of 216 Terry turbines at the Lake Charles refinery of this same company showed amazingly low maintenance costs. During this period, the yearly cost of replacement parts averaged only 1.4% of the initial investment.

The two turbines at East Chicago are rated 2450 horsepower at 5030 rpm. Each is equipped with a trip throttle valve, forced feed lubrication, and regulator for process control applied to a variable speed oil relay governor.

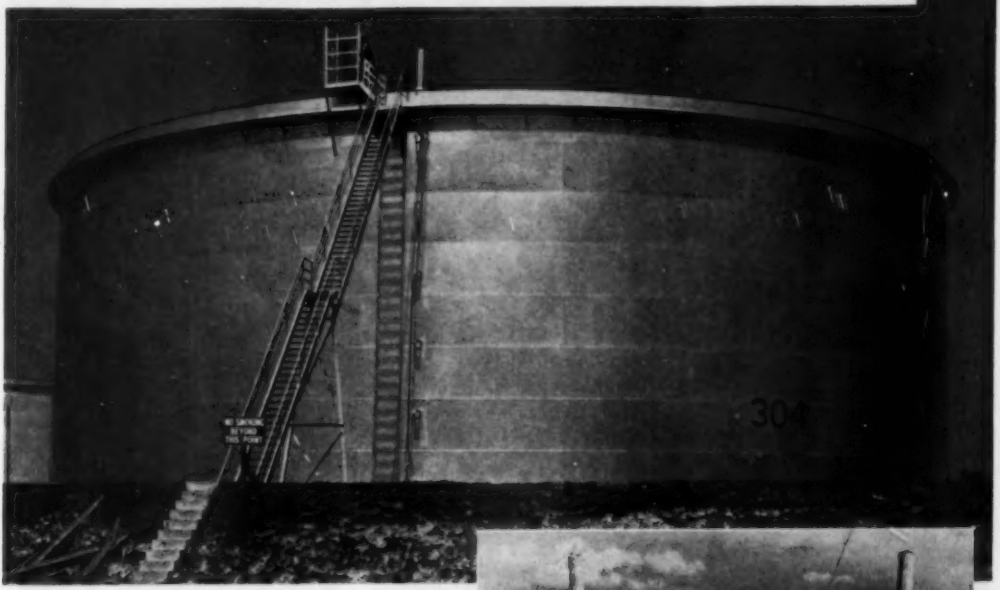
For more information about Terry multistage turbines, send for a copy of Bulletin S-146. No cost or obligation.

TERRY

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1193

GREAT BRITAIN'S "ACE IN THE HOLE"

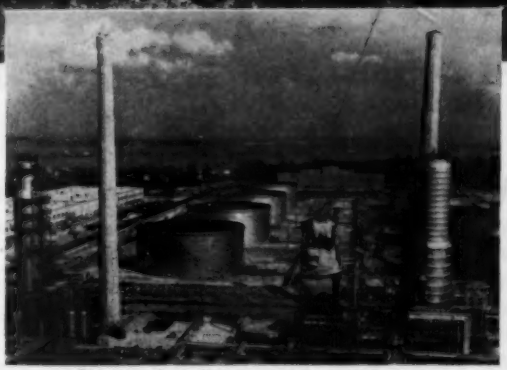


Horton Tanks Serve Giant Refinery at Fawley

Faced with the loss of Abadan, the world's largest oil refinery, Great Britain still has this *ace in the hole* at Fawley, England. It's the Esso Petroleum Company's giant 100-million dollar refinery which went on stream in September. In its first year, Fawley is expected to produce 5.5 million tons of gasoline, bunker fuel, jet fuel, naphtha, asphalt, lubricating oils, and kerosene. That's more than twice the amount of refined products imported from Iran.

Playing an important part in the successful operation of this huge refinery are thirteen 140-ft. diam. by 34-ft. tanks equipped with Horton Pontoon Floating Roofs. They were built in England by Whessoe Limited, a Chicago Bridge and Iron Company licensee.

Horton *Pontoon* Floating Roofs ride directly on the liquids stored in tanks. By eliminating the air vapor space, they eliminate breathing and filling evaporation losses, cut down on corrosion and reduce the danger of fire in the storage area.



The view above illustrates a portion of the giant Esso Petroleum Company refinery at Fawley.

For more information on Horton Floating Roofs or any other Horton structure, write our nearest office.

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W-S Screw-End and Socket-Weld Fittings

That's right, W-S emphasizes the *plural* when it comes to the various steels for forged fittings.

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And there's one problem common to all . . . COST. Let us show you how W-S *forged* fittings provide the lowest *service* cost obtainable.

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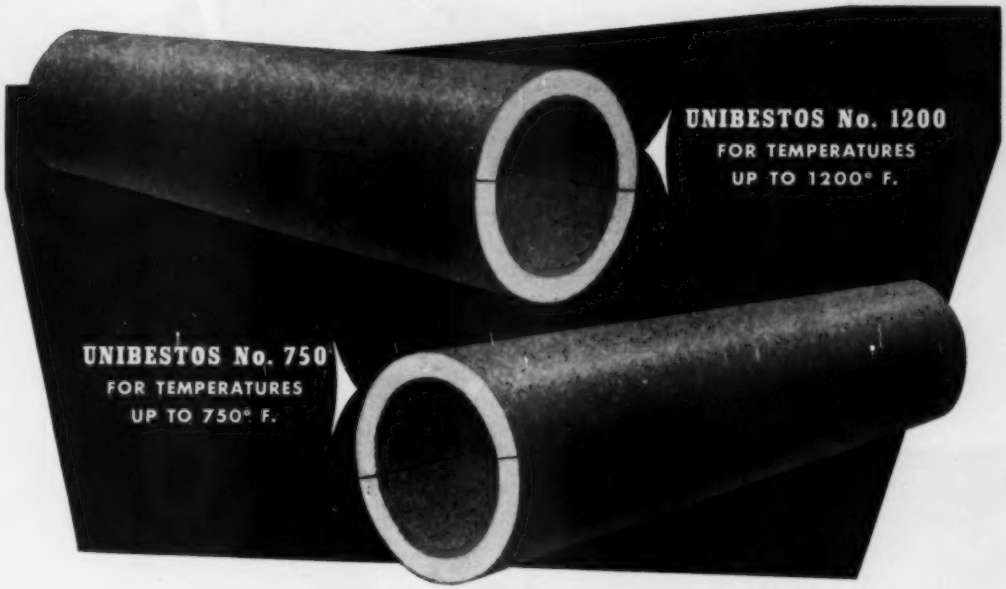

These famous UNIBESTOS twins cut heat loss and surface temperature

HIGH EFFICIENCY IS UNIMPAIRED BY REUSE OR CONTINUOUS SERVICE

When you insulate with Unibestos you can be sure of *prolonged* effectiveness, for this durable African Amosite product resists all service hazards. It's unaffected by moisture, steam, fumes . . . withstands impact and vibration . . . won't shatter, crumble, powder, or dust to contaminate the atmosphere under normal service conditions.

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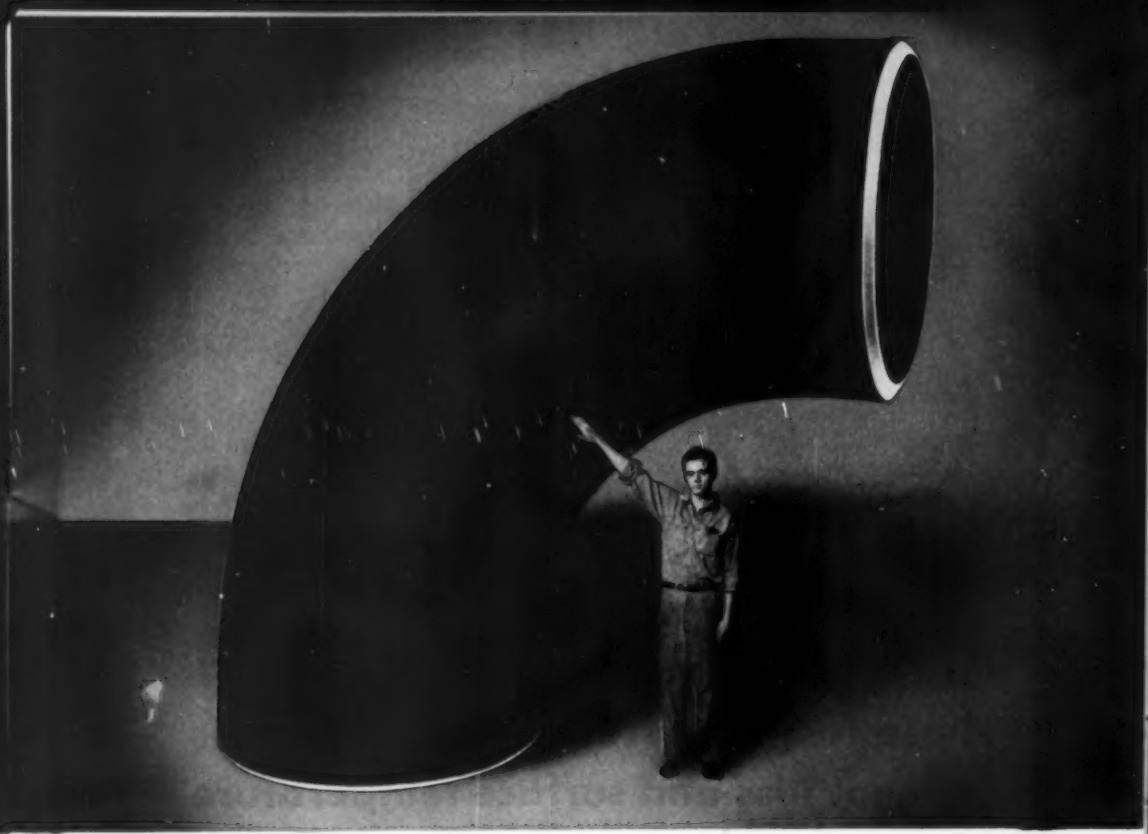

We Haven't Made Them This Big... *YET,*

but this photographic fantasy is simply to remind you that we do manufacture the most varied line of welding elbows on the market.

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PIPING & SUPPLY CO., Inc.

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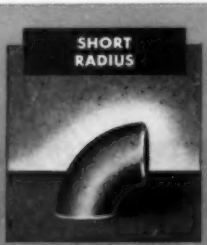
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

Same radius as ASA but tangent equal to 25% of nominal pipe size on each end. Saves pipe, layout and welding time. Costs no more than ASA. Sizes to 24".

Dimensions conform to applicable size range of American Standard for Butt-Welding Fittings, ASA B16.9. Tolerances much less than allowable. Sizes to 36".



Recommended where space limitations do not permit use of "Long Tangent" or ASA Elbows. Sizes to 30".

Takes the place of a straight size elbow and a reducer. Eliminates one weld, reduces pressure drop, easier to insulate. Sizes to 12", reductions to half size.

4539

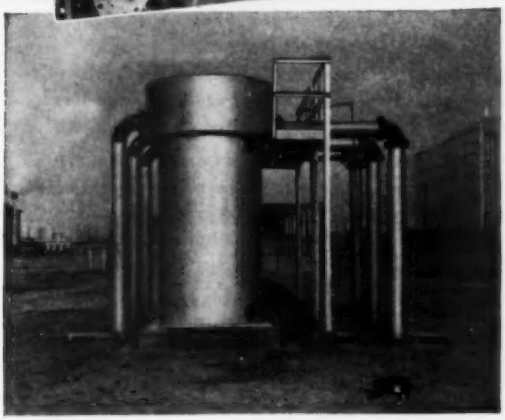
Dirty Water can't "Shut-down"...

Vogt

film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

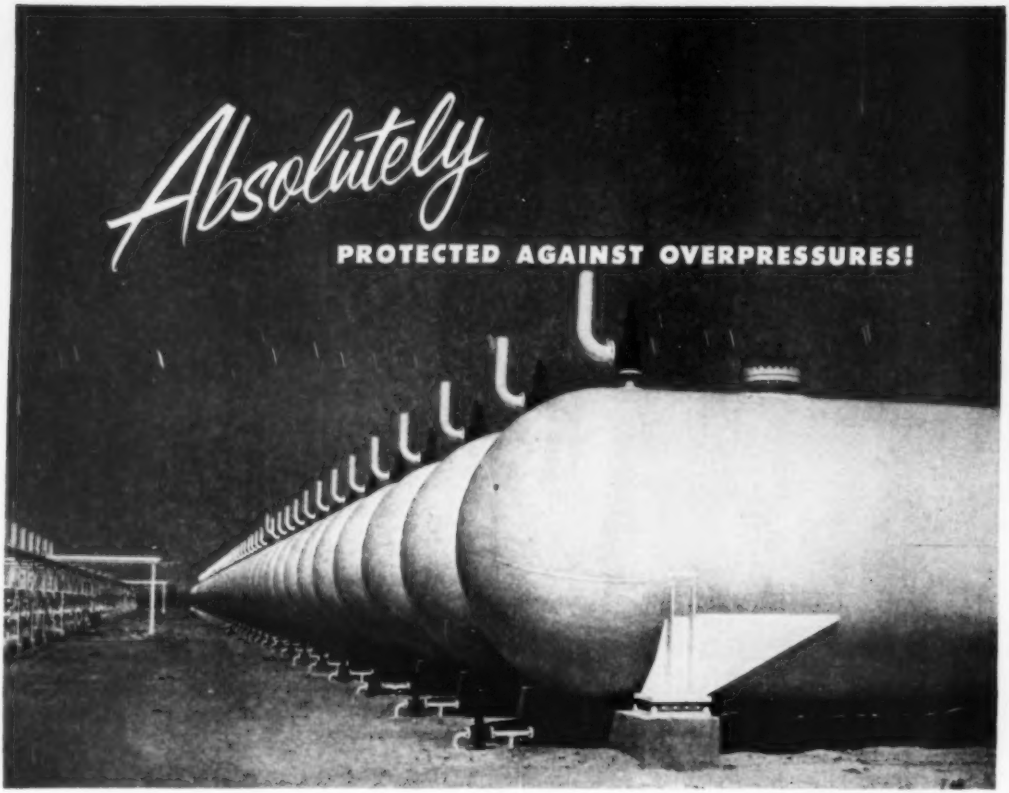
TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



Uncontrolled pressures in processing equipment invite disaster. That's why so many unfired pressure vessels—gas, vapor and liquid storage tanks, pipelines, pumps—are protected by Consolidated Safety Relief Valves.

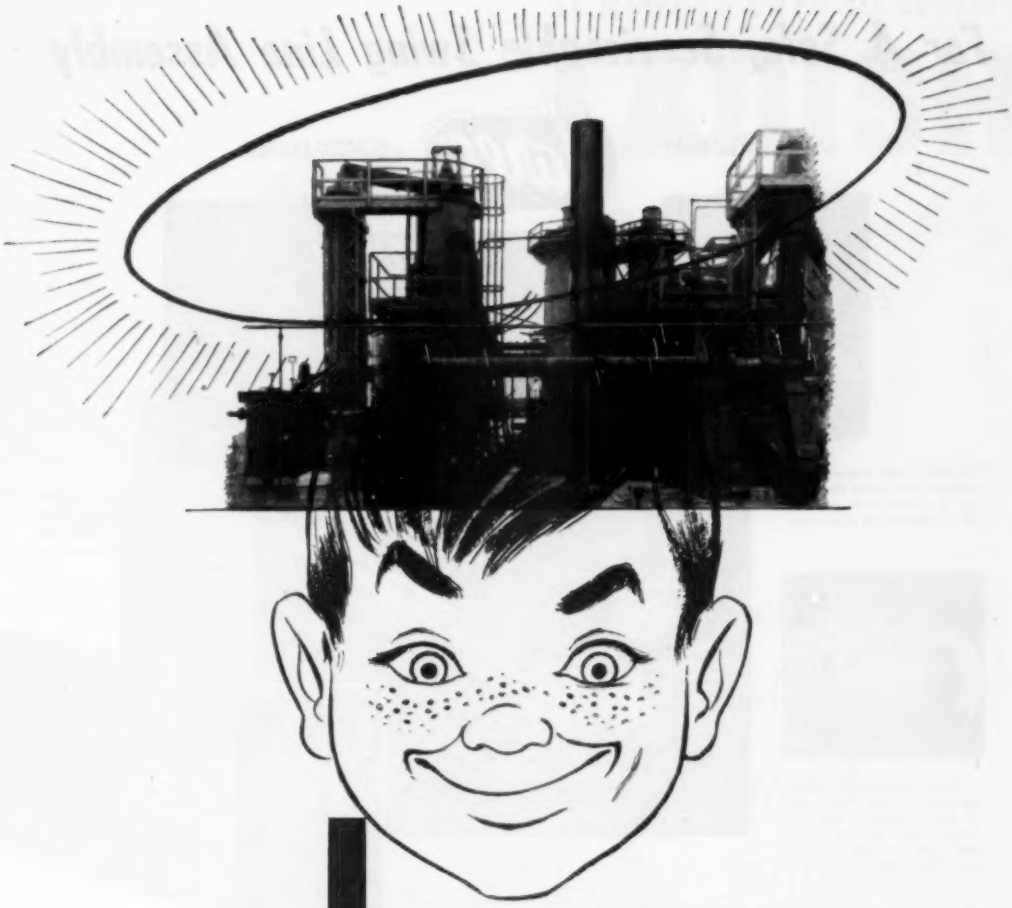
Dependable tightness is foremost in valve safety standards. Consolidated Safety Relief Valves don't leak under discharge piping stresses because outside bevel seat and floating guide construction permit the disc to be moved on a radial seating surface. Tightness is absolute in all positions within the deflection range. Continuously reliable performance at the rated capacity safeguard life, property and production, even in the severest service.

Consolidated Safety Relief Valves are widely used for another basic reason: *simple design.* With 25% fewer parts than ordinary safety relief valves, service and standardization problems are reduced, maintenance costs are cut. Get all the facts first hand. See your local Consolidated Distributor.

CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.



"stepchild" becomes a favorite son

If the refinery waste "stepchild" is an expensive nuisance, change it to a favorite son with a Monsanto-Ross-Wilde sludge recovery unit.

With a Monsanto-Ross-Wilde unit, you can make clean, white sulfuric acid, of any desired strength, from sludge, from H_2S, or from both together. The unit will operate with your present contact sulfuric acid plant. If you have no plant, Monsanto will design your sludge recovery and sulfuric acid units as a single project.

In addition to making high-quality sulfuric acid, the Monsanto-Ross-Wilde unit often recovers oil that can be refined into salable products. It can also give you by-product steam for heat or power.

You save money, too. Freight costs of hauling away sludge and returning recovered acid are eliminated. And you improve community relations by doing away with stream and atmospheric pollution.

At your request, and without obligation to you or your company, a Monsanto representative will visit your refinery and estimate the cost of a Monsanto-Ross-Wilde installation. He will show you how much acid you can produce . . . how much you'll save on waste disposal costs. Write, wire or telephone for details. MONSANTO CHEMICAL COMPANY, Engineering Sales Department, 1776-C South Second Street, St. Louis 4, Missouri.

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CHEMICALS – PLASTICS

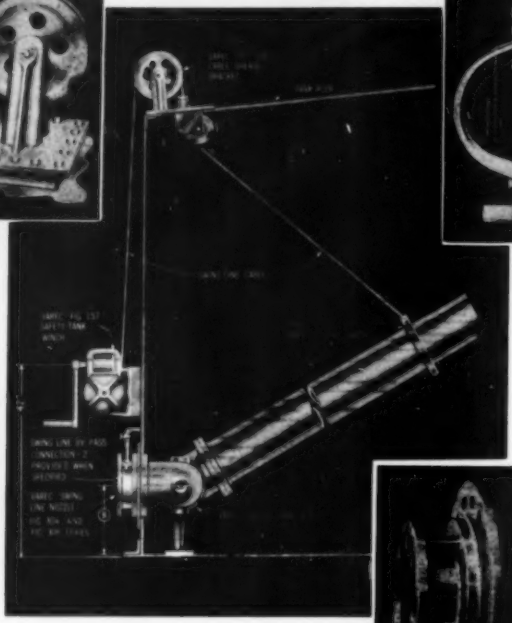
SERVING INDUSTRY . . . WHICH SERVES MANKIND

For A Safe, Serviceable Swing Line Assembly

SPECIFY "Varec" **EQUIPMENT**

"VAREC" Cable sheave Bracket equalizes pull in both directions. Pull is straight down on either side to eliminate all angularities.

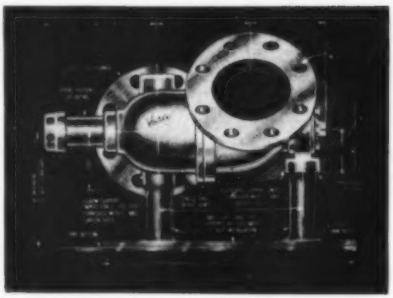
"VAREC" Cable Collar Clamps provide a simple, fool-proof means of connecting swing line cable to swing line pipe.



"VAREC" Safety Tank Winch dependably sustains loads without use of clutches or dogs. Enclosed worm and gear drive. 1500, 2500 and 5000 lb. capacities.

"VAREC" Double or Single (shown above) Swing Line Assemblies afford the utmost in safe, reliable and trouble-free operation.

"VAREC" Tank Shell Nozzles provide a rigid, leak-proof connection between inside swing joint and outside valve or pipe line. Extra heavy, hydrostatically tested.



"VAREC" Swing Joints facilitate raising and lowering swing lines inside storage tanks. Patented control sleeve prevents elbows from parting under any condition.

"VAREC" Swing Line Equipment in addition to affording many important operating conveniences is built for extra years of dependable, trouble-free service with safety. Each component part is made with extreme care to eliminate servicing of both internal and external parts.

"VAREC" Engineering Department and Testing Laboratory will gladly collaborate with you on any problems regarding Swing Line Equipment, so when the "specs" say Swing Line, specify "VAREC" for satisfactory service and safety.

"Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

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IT ALWAYS PAYS TO SPECIFY

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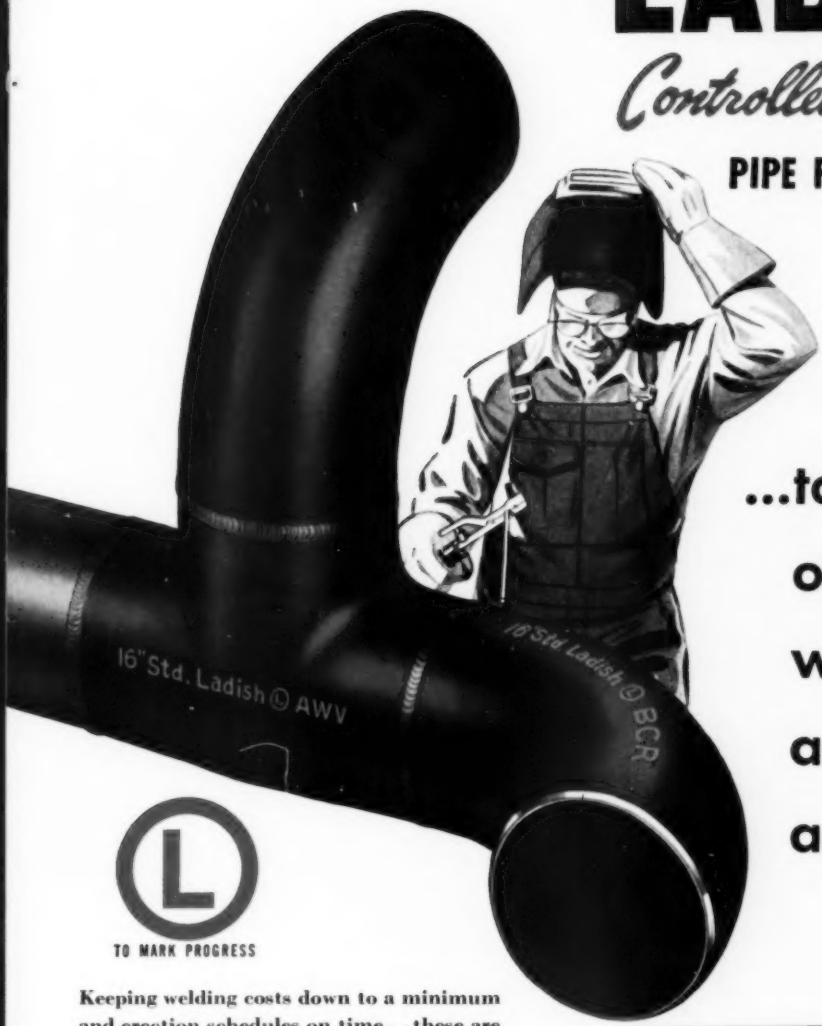
Controlled Quality

PIPE FITTINGS



...to be sure of sound welds and fast assembly

TO MARK PROGRESS

Keeping welding costs down to a minimum and erection schedules on time... these are important advantages you can assure to any piping job by installing Ladish Controlled Quality fittings. Metallurgical controls over materials and methods provide an assurance of uniform weldability in every Ladish fitting... and thorough inspection to rigid standards of physical dimensions and geometric accuracy assures fast piping assembly.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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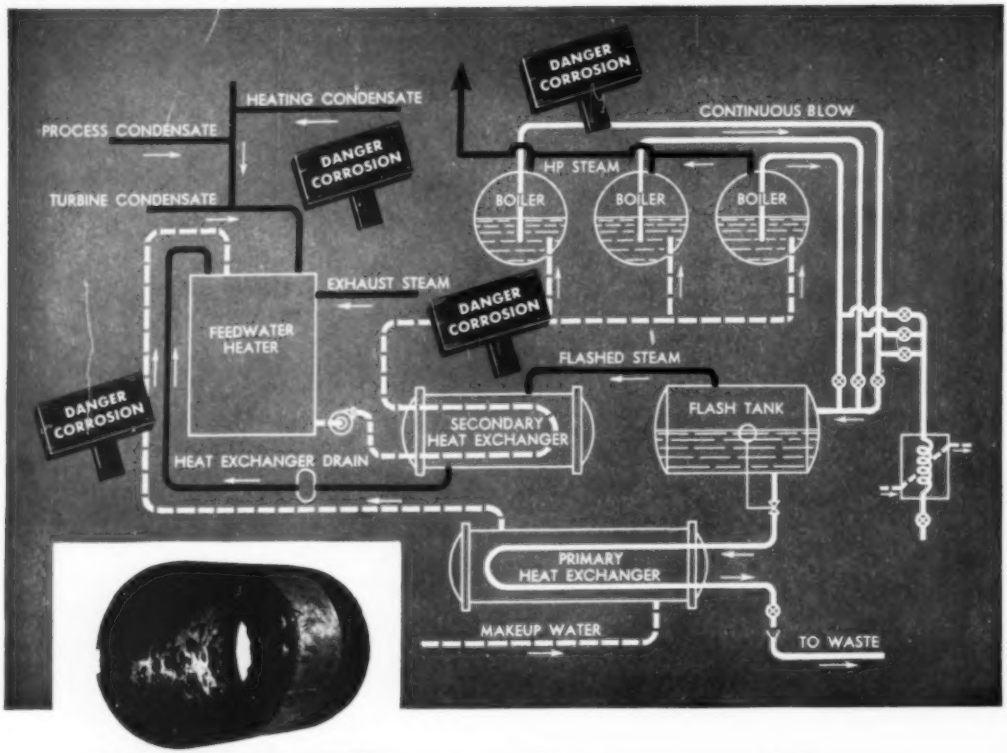

AVOID These Danger Signs with BIRD-ARCHER Amine Treatment

CORRODED condensate return lines lead to expensive pipe replacement and maintenance. As an added annoyance, the solid products of corrosion often plug return lines and fill traps. You can steer clear of these troubles by using the *effective, economical* Bird-Archer Amine Treatment.

HERE'S THE WAY THIS B-A TREATMENT WORKS

Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself.

HERE'S HOW THIS B-A TREATMENT SAVES MONEY

Raising the pH value of the condensate severely decreases maintenance costs by eliminating corrosion. These savings may more than offset the amount of treatment required to provide protection for your equipment.

NEW BULLETIN gives full details on the Bird-Archer Amine Treatment. . . . contains case histories that prove its successful application in many plants. *Write for your copy today.*

BA-194

WHAT AMINES ARE

Amines are members of a class of chemical compounds in which one or more hydrogen atoms of the ammonia molecule are substituted by an organic group. Some of the simpler types are soluble and volatilize from boiler waters. The alkalinity of the amines is an inherent property and does not result from decomposition. *No free ammonia is released.* In the concentrations necessary for protection of condensate systems, amines are harmless to non-ferrous metals, non-toxic and are completely stable at temperatures approximating 675F.

BIRD·ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 NORTH AMERICAN ST., PHILADELPHIA 40, PA.
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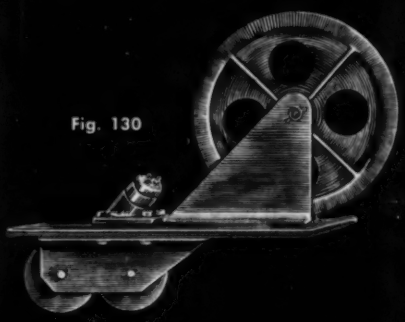
TOP NOTCH STARS

That's the distinction earned by the Shand & Jurs team of Swing Line Equipment. It is a distinction resulting from years of superlative swing line performance under all types of weather and rugged operating conditions in the field. Here is why S&J Swing Line Equipment merits this fame. S&J Builds Quality into each unit of its swing line equipment so that it will deliver maximum DEPENDABILITY, SAFETY and ECONOMY. That is why S&J Swing Line Equipment wins top performance laurels wherever it is installed

Fig. 130

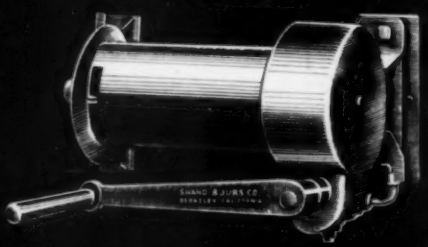


S&J Swing Line Cable Sheave Bracket, Fig. 130, employs cast iron stuffing box. Also available with oil seal for moderate tank pressures.

S&J Cable Winch, Fig. ST-4380, utilizes machine cut, anti back-lash gears which run in an oil bath. Handle designed for maximum mechanical advantage.

S&J Double Elbow Swing Joint, Fig. ST-235, is mounted on tank shell only. Settling or shifting tank bottom can not affect its easy swing.

Fig. ST-4380



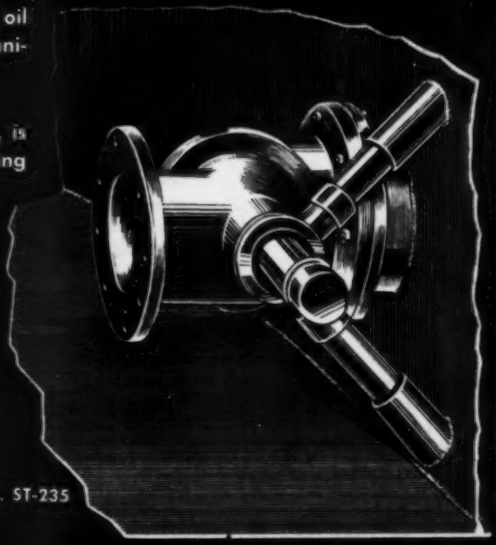


Fig. ST-235

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In refineries, lube oil plants and tank farms throughout the country, LIGHTNIN Mixers are doing hundreds of mixing jobs faster, better, at lowest cost. Applications include:

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fluid agitation specialists

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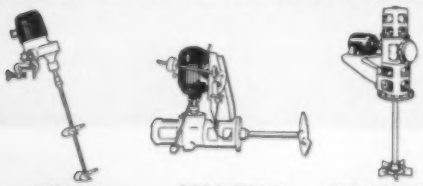

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1 to 25 HP

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Under a roof of pipes, which course through the process area of Stanolind Oil and Gas Company's North Cowden, West Texas, gasoline plant, a process man stops to read instrument controls.

PETROLEUM REFINER

The LOOK BOX

Manpower, Critical Problem

MANPOWER shortages would hinder the petroleum industry's ability to maintain present daily average operating levels of crude oil output of a little more than six million barrels and refinery runs of about 6.5 million barrels should a substantial increase be ordered in the armed forces current strength of approximately 3.6 million men.

In the event of an all-out war the inroads into the industry's labor force would be severe in all categories of employment, regardless of how essential to the defense effort individual jobs might be.

These are the opinions of manpower specialists of the Petroleum Administration for Defense. They estimate a 10 percent reduction in the present personnel of the producing, refining and pipe line branches of the industry—not a large bite if war should come—would force some cutbacks from current operating levels.

For the industry, the general labor situation ahead even under only partial mobilization is one of shortages of technical personnel. And as the size of the armed forces is increased, shortages may be felt in the ranks of skilled and unskilled labor. This is a situation that must be faced by the petroleum industry during the defense build-up. PAD officials suggest that now is the time for the industry to re-examine training programs with the view of improving methods and techniques to shorten instruction periods for the limited new personnel that will be available to enter the field.

Engineer Shortage

THE DANGEROUS GAP between the supply of engineers and the need for their services is becoming wider according to a report made by the U. S. Office of Education and issued jointly by that office and the American Society for Engineering Education.

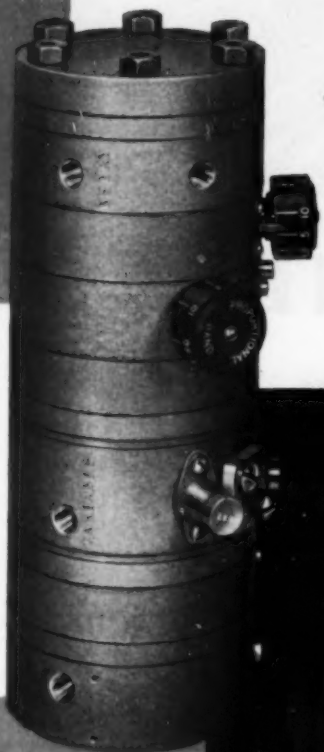
Only 28,000 engineering students will graduate in 1952 to meet the current demand of from 60,000 to 90,000 engineers. There were 38,000 engineering graduates in 1951; consequently the supply of engineers this year will be 10,000 fewer, a reduction of more than 25 percent. Since many of the 1952 graduates are either members of ROTC units or are subject to the draft, having been granted deferments to complete their college courses, defense industry is likely to find itself with a deficit of from 40,000 to 70,000 engineers.

The graduation of the last large group of veteran students has dropped the total engineering enrollment 8.4 percent below that of last year. This decrease, however, compares favorably with the decrease in male student population reported by all higher educational institutions, which is almost 11 percent smaller than in the fall of 1950.

A checking of the decline in engineering enrollment is indicated by an increase in the number of freshmen engineering students of 16.2 percent over 1950. Industry will not, however, have a chance to benefit by this increase until four years hence when it will find that it has heavy competition from the armed services, since an increasing number of freshmen are joining ROTC units.

The increasing desire for graduate training in engineering is reflected by the fact that graduate enrollment is now three times what it was in 1940. At that time, the graduate students comprised

Important

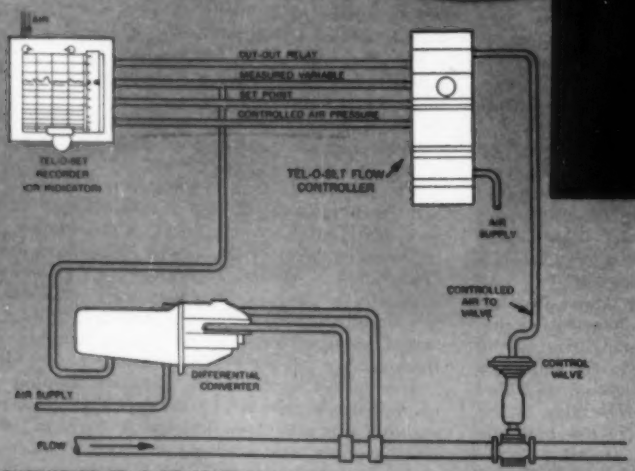


TEL-O-SET CONTROLLER

Available in adjustable and fixed proportional band models, and with three control forms . . . for flow, temperature, pressure, level and other process variables. Universal bracket permits optimum flexibility in mounting . . . coded, interchangeable sections and split manifold contribute to simplified maintenance. Write for Specification Sheet No. 768.

TEL-O-SET RECORDER

Features withdrawal of chassis for full 8-hour chart visibility without interrupting operations, bumpless shifting from automatic to manual operation, all adjustments from front of panel, built-in adjustable restrictions for pulsating flow . . . requires panel space just 5 1/16" high by 5" wide. Write for Specification Sheet No. 769.



TYPICAL ENGINEERED *TEL-O-SET* CONTROL SYSTEM—Pictured in this diagram are the elements of the *Tel-O-Set* Family, designed and built as an integrated loop. Here the system is applied to the control of flow with the *Differential* Converter used as transmitter.

TEL-O-SET INDICATOR

Can be used with any pneumatic transmitter, having a 3-15 psi controlled air output, regardless of the primary element being used. Provides indication of process variable, set-point of controller or controlled air pressure to valve when on automatic control . . . is easily shifted to manual operation. Panel cut-out size same as recorder. Write for Specification Sheet No. 770.

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THIS pace-setting pneumatic control system is ready for application to a host of processes demanding a new high in speed, precision and accuracy . . . for almost any process variable. Developed as part of a family relationship, each unit complements the others in producing a system of superior performance.

Used with any one of a group of Honeywell measuring elements . . . for flow, temperature, pressure, liquid level, etc. . . . the *Tel-O-Set* system is destined to make important contributions to the improvement of process control throughout industry.

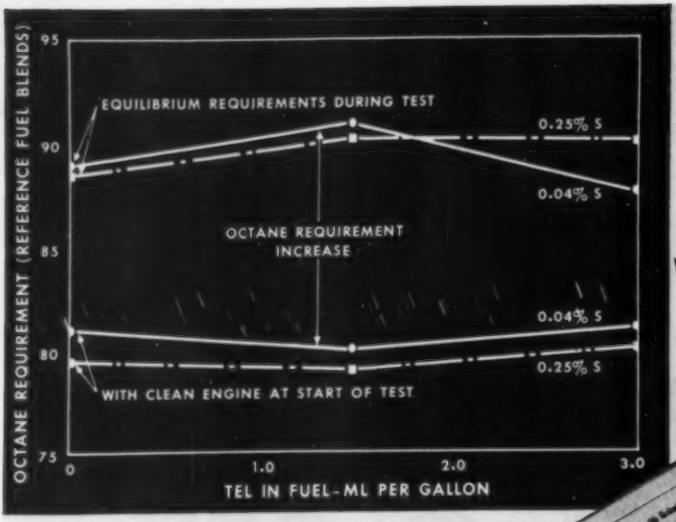
For more detailed information, send for the literature mentioned in the descriptions at left . . . or call in our local engineering representative for a discussion of your process control problems.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa.

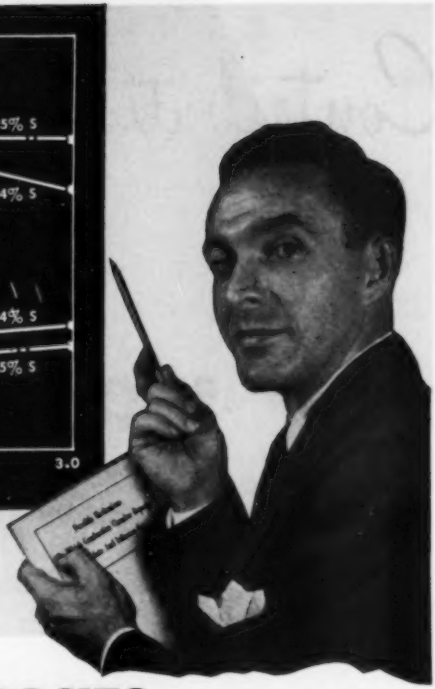
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls



This chart shows the results of tests conducted as part of a program carried on at the Du Pont Petroleum Laboratory to determine the factors affecting octane requirement increase. The clean engine requirements at the start of each test and the equilibrium requirements observed are plotted as a function of the amount of tetraethyl lead used.



HOW DO ENGINE DEPOSITS AFFECT OCTANE REQUIREMENTS?

Du Pont Petroleum Research offers new findings

Deposits are generally admitted to be a contributing cause to engine knock. Since knock has long presented a problem to petroleum and automotive engineers, the results of Du Pont deposit studies in connection with knock may be of interest to you.

Data from these studies show, for example, that knocking tendency of the combustion chamber deposits is independent of the amount of both tetraethyl lead and sulfur present in commercial type fuels and lubricants. Fuels containing up to a 3.0 ml TEL per gallon were used in the tests.

The Du Pont Petroleum Laboratory also investigated the volume effect, the catalytic action and the thermal insulating effect of deposits on octane requirement. The results indicate that the effect of deposits in increasing knocking tendency is not primarily catalytic . . . but that the volume and thermal insulating effects of deposits both contribute to raising octane requirement.

As part of the work in helping refiners obtain knock-free fuel performance through the use of tetraethyl lead compounds, Du Pont has made the findings of these studies available in booklet form. Ask your Du Pont representative for a copy of "Possible Mechanisms By Which Combustion Chamber Deposits Accumulate and Influence Knock" . . . or write direct to the nearest district office.

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only 4.6 percent of all engineering students. This fall, 13.1 percent of all engineering students are taking graduate work. For the entire college population, the percentage of graduate students is estimated at about 10 percent. Almost 28 percent of all engineering graduate students are taking their training in electrical engineering. Mechanical engineering accounts for about 17 percent, while approximately 13 percent are enrolled in chemical engineering.

The distribution of bachelor's degrees granted in 1951 among the four principal undergraduate engineering curricula was as follows: mechanical engineering, 9,609, electrical engineering, 8,616, civil, 6,473 and chemical, 3,614. The number of graduates in each of the four curricula was considerably lower than the previous year. In mechanical engineering, 26.4 percent fewer graduated. About 30 percent fewer were graduated in electrical engineering, 11.5 percent fewer in civil, and 18.3 percent fewer in chemical.

Stocks Are Mal-distributed

ALTHOUGH the nation's total refined product stocks seem fairly well in balance with expanded needs, there are indications that inventories are mal-distributed and may result in local shortages. Heavy drafts on product stocks on the West Coast may cause shortness in supply, while build-ups in some Middle West states are pushing volumes towards excessiveness.

The nation's combined stocks of the three major products appear in favorable position at 10 million barrels over year ago levels, but the hikes have been confined to motor fuel and distillate fuel oil, as residual fuel oil inventories have declined.

California now has 12 million barrels less of major products in storage than at corresponding period of 1951 and 27 million below 1950 level. Meanwhile the rest of the nation has 23¾ million more barrels in tanks than it had a year ago. Almost half of the U. S. increase has developed in the Illinois-Indiana-Kentucky region, where refiners have 10½ million barrels more than were on hand a year before.

Heavy withdrawals in California are responsible for U. S. residual stocks being 2½ million barrels under last year's level and 14 million less than 1950's. However, these stocks are 5 million higher outside the West Coast and one-half of this gain has occurred in the Illinois-Indiana-Kentucky area.

The same is true for the distillate fuel oils. Stocks are down on the West Coast and up in other parts of the country, with one-half the rise in the same Middle West states. Practically the same pattern fits the motor fuel stocks picture, with California's under last year's levels and the nation's as a whole on the increased side. Again a large part of the nation's gain was found in the Middle West.

Competitive vs. Cooperative Research

APPLIED research must remain competitive if it is to be productive, Dr. Robert E. Wilson of Chicago, chairman of the board of Standard Oil Company (Indiana), stated in a recent address to the American Association for the Advancement of Science. Cooperative research suffers from the absence of an incentive to make a profit and to get ahead in the competitive struggle. It also abandons the proved advantages of many independent centers of initiative and different methods of attack on difficult problems.

Pointing out that applied research on a major scale is a product of only the past third of a century, Dr. Wilson stated that it has revolutionized many industries and raised the standard of living more than any other development in world history. Given a fair chance, research can contribute far more than it already has to enrich and lengthen human life. Because of petroleum research, gasoline is the cheapest commodity on the market today, relatively speaking.

Petroleum refining has become essentially a chemical-synthesis industry and the magnitude of its operations dwarfs all the synthetic processes and products of the old line chemical industry. Research has also made petroleum an increasingly important source of many vital products formerly manufactured from other raw materials. As to the future, the Standard Oil executive stated that the industry has developed several processes by which oil products can be made from coal or other non-petroleum sources, just as soon as there is economic justification for doing so.

In spite of the fact that over 90 percent of the applied petroleum research that has brought about these public benefits is carried on today by the competitive oil companies, this research faces the same threats that hamper all industrial research, Dr. Wilson declared. Among these threats he named possible emasculation of the patent system, compulsory licensing, and government competition in the field of applied research. Another threat is high taxes, which take away incentives for applied research and also reduce incentive to business to develop and install new processes.

The conditions needed for competitive research to be most productive, in the light of industrial experience in the U. S., says Dr. Wilson, include:

1) There must be a reasonable number of strong companies, able to attack problems aggressively from different viewpoints.

2) There must be a sound patent system, to furnish incentives and at the same time to encourage prompt publication of research results.

3) There must be freedom and willingness to license others at reasonable rates, and to enter into cross-licensing arrangements where needed.

4) There must be no agreements in restraint of competition.

Have You Taken This Opportunity for

COLONEL, RESEARCH AND DEVELOPMENT DIVISION, DEPARTMENT OF THE ARMY: "Full support should be given any sound measure designed to encourage inventors and facilitate consideration and further development of their ideas or inventions. It is difficult to conceive of any action that would accomplish more in this direction than that called for in the Sinclair Plan."

CABINET MEMBER: "It should bring to light some valuable ideas which might otherwise not have been known."

AN INVESTMENT COUNSELOR: "I can imagine the great surge of hope now going through the breasts of the young men specializing in this field. 'Here,' they will say, 'is a corporation willing to give us a break.' . . . Its fundamental unselfishness cannot fail to strengthen the faith of those without property. . . . This is opportunity!"

AN AIR FORCE GENERAL: "I have read of your plan for encouraging invention and offering a testing ground for ideas. Such a project seems to me both practical and inspirational!"

A CABINET MEMBER: "The provisions regarding patents are unique . . . the compensation for your investment of money, time, and facilities would be limited to nonexclusive, royalty-free shop rights for your company."

Men Who Know the Importance of Independent Invention Encourage You to Use the Sinclair Plan

A MEMBER OF THE JOINT CHIEFS OF STAFF: "The Sinclair Oil Corporation is performing another fine public service in opening its research laboratories to the American inventor. I am confident that the nation will derive many benefits from this selfless service."

PRESIDENT OF A BROADCASTING NETWORK: "To make the magnificent facilities of the Sinclair Research Laboratories available to inventive Americans under what would seem to be a very fair arrangement is a constructive and forward-looking step."

PRESIDENT OF LARGE MANUFACTURING CORPORATION: "We all think the plan, which opens wide the doors of your great research laboratories, should indeed encourage individual inventors."

AN AIR FORCE GENERAL: "I wholeheartedly agree that there is a need to help the independent inventor because of the complexity of modern technology and the prohibitive cost of these facilities. Your farsighted plan is a great stride in relieving this situation."

PRESIDENT OF A LARGE MANUFACTURING COMPANY: "You have recognized a great need, and have done something objective to overcome it . . . another idea which puts to beneficial use the resources and capacity of a large group."

Advantage of Independent Inventors?

If you have an idea for a new petroleum product—but do not have the facilities needed to develop it—the Sinclair Plan offers you laboratory help.

EIGHT months ago, Sinclair opened up a part of its great research laboratories to independent inventors who had ideas for new or improved petroleum products but who did not have the facilities needed to develop and profit by their ideas.

To date nearly 5,000 inventive people have submitted ideas to the laboratories; and the Sinclair Plan has become recognized as a service to inventors, the oil industry and the public. As a result we have made the Plan part and parcel of the long-range operation of our company.

If you have an idea for a new or improved petroleum product or application, you are invited to submit it to the Sinclair Research Laboratories. In your own interest, each idea must first be protected by a patent application or a patent.

If the laboratories select your idea for development, they will make a very simple arrangement with you: In return for the laboratories' work, Sinclair will receive the privilege of using the idea for its own companies, free from royalties. This in no way hinders the inventor from selling his idea to any of the hundreds of other oil companies for whatever he can get. Sinclair has no control over the inventor's sale of his idea to others, and has no participation in any of the inventor's profits through such dealings.

HOW TO PARTICIPATE: Instructions are contained in an Inventor's Booklet. Write to W. M. Flowers, Executive Vice-President, Sinclair Research Laboratories, Inc., 600 Fifth Avenue, New York 20, N. Y.

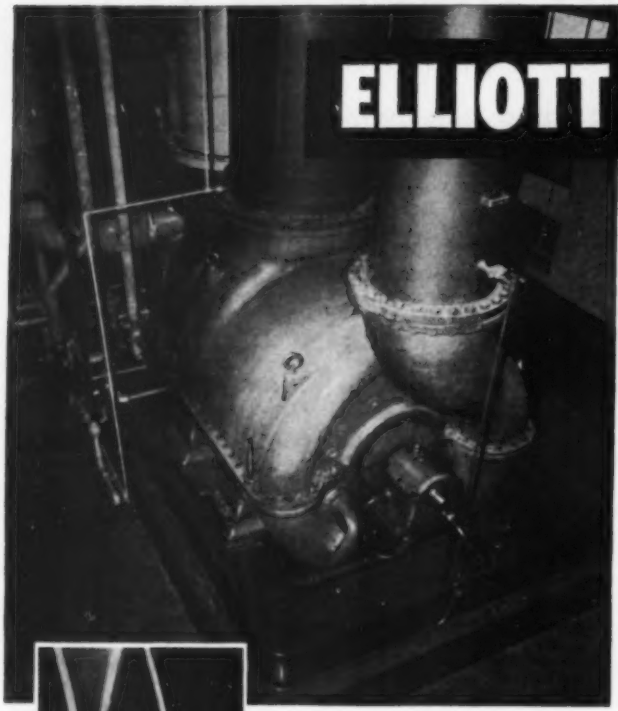
IMPORTANT: *Please do not send in any ideas until you have sent for and received the instructions.*

Nine buildings of the Sinclair Research Laboratories at Harvey, Ill.

SINCLAIR—for Progress

Cat cracking calls for the "year-round" service of

ELLIOTT BLOWERS



WELDED IMPELLERS are one of the many reasons why Elliott blowers are getting ever-increasing acceptance for process work. Note the smooth contours, heavy blades, and generally rugged construction (as compared to conventional riveted impellers). These impellers are completely homogeneous and can be made of any weldable material having reasonable mechanical strength.

CONTINUOUS AND reliable performance is an established characteristic of Elliott centrifugal blowers. This is proven in numerous modern refineries where large quantities of air are required for conveying and regenerating catalyst.

The blower installation pictured is typical. Serving an important mid-west refinery, it is rated at 30,000 inlet cfm, compressing air to a discharge pressure of 26 psig. Day and night this blower is driven at 4750 rpm by an Elliott direct-connected 3140-hp condensing steam turbine.

In recent months an Elliott blower in cat cracking service broke all records for continuous operation —677 days. The previous non-stop record of 610 days was also held by an Elliott blower. Performance like this spells *profit.*

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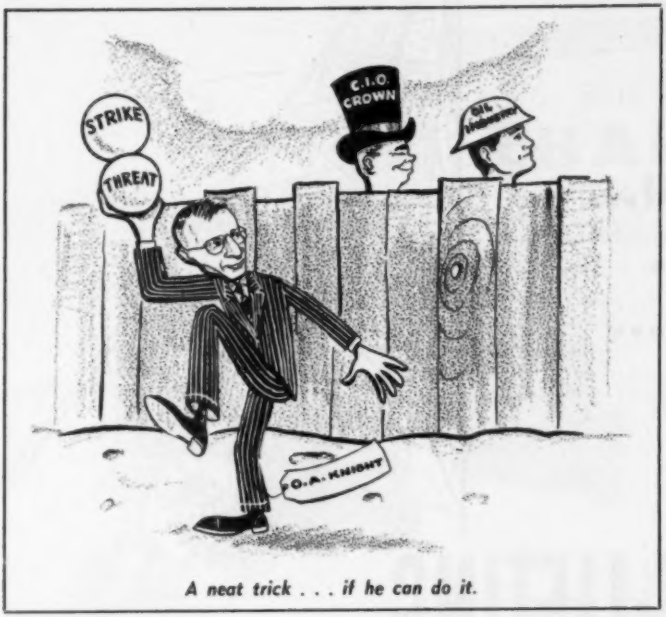
P-1093

Elliott Blowers—*the heart of the cat cracker*



A neat trick . . . if he can do it.

That's What the Man Said!

O. A. (Jack) Knight, president of OWIU, has been assistant administrator of the National Production Authority since 1951 and is paid $15 each day he serves in Washington.

In view of the strike threat, Knight could be criticized for obeying too literally the directive in NPA Regulation 1. It begins: The purpose of NPA Regulation 1 is "to prevent the accumulation of excessive inventories of materials . . ."

Crude stocks in the U. S. at the close of 1951 were higher than at the end of any year since 1948.

Oil Union Strategy Wins Government Intervention

INDUSTRY workers clamoring for higher pay could claim another victory this month, but their leader was reacting like a general who had won a battle while endangering a campaign.

President Truman's proposal that the dispute be referred to the Wage Stabilization Board until April 9 met ready acceptance from most of the 22 independent and AFL unions involved but quick opposition from O. A. (Jack) Knight, president of the CIO Oil Workers International Union and master strategist behind labor's demands. The OWIU chieftain gave grudging 11th-hour consent to the delay when his loosely-built coalition of strike-bent unions threatened to fall apart.

This new postponement of a strike originally set for March 3 and then put off a week at the behest of federal mediators brought the oil workers nearer their one big goal of a 25-cent-per-hour pay hike plus 6 and 12-cent premiums for the night shifts. That the delay also moved Knight nearer another big goal—industrywide bargaining—there could be no doubt. But there was evidence that the OWIU president thought he knew a more direct route that would bring quicker action for the oil workers, greater prestige for OWIU, and more recognition for Jack Knight.

In going before the WSB, the 275,000 oil workers are lined up to the rear of a million steel workers who have been assaulting government barriers against higher pay and a new whirl in the inflation spiral. WSB must satisfy the steel workers' demands before March 23, nearly two weeks before the oil workers' new strike deadline—and this may be exactly the margin by which Knight misses the opportunity of personally wrecking the entire system of government wage controls.

Had the oil workers elected to follow Knight's schedule, the government may have been forced to 1) call the strike a national emergency under the Taft-Hartley law; or 2) bypass the Taft-Hartley machinery and, as in the railroad case, order outright Army seizure of the nation's oil industry.

Since it is inconceivable that this vote-conscious government would risk the ire of the workers and the oil-consuming public in an election year, either path might have allowed the oil workers the honor of being first over the government's inflation barrier now being stormed by steel workers, mine workers, aircraft and aluminum unions and Western Union workers. Such an achievement would bring OWIU the applause from 12 million to 13 million workers in all industries who are waiting for a new wage pattern to form before demanding their share.

It would also:

- Bring into the OWIU fold a number of independent unions which have been chary of joining the CIO affiliate which was badly beaten in the 1948 California strike and later led its members into the long hardship of The Texas Company rift.
- Raise OWIU abreast of the steel and auto workers, heretofore the big voice in CIO councils because of national unification which has won progressive labor gains.
- Make Knight a respected dark horse in the coming struggle for CIO leadership. (At Denver, where the March 3 strike deadline was set, Knight was asked: "Are you a candidate for Phil Murray's job?" His reply: "My

Fishtail...
Roller...
Drag...

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How Petroleum Workers' Wages and Hours Compare with Other Labor Groups in U. S.

	ALL MFG. INDUSTRIES			CRUDE OIL & NATURAL GAS PRODUCTION			PETROLEUM REFINING			BITUMINOUS COAL			BLAST FURNACES[1]			AUTOMOTIVE		
	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Average Weekly Earnings	Average Weekly Hours
1951*	$1.625	$65.81	40.5	$1.967	$79.27	40.3	$2.094	$84.18	40.2	$2.235	$90.46	36.6	$1.882	$77.73	41.3	$1.952	$76.91	39.4
1950	1.465	60.33	40.5	1.815	73.89	40.6	1.929	77.93	40.4	2.010	70.35	35.0	1.691	67.47	39.9	1.778	73.25	41.2
1949	1.401	54.92	39.3	1.778	71.48	40.2	1.874	75.33	40.2	1.941	63.28	32.6	1.646	63.04	38.3	1.696	65.97	38.9
1948	1.350	54.14	40.1	1.687	66.68	40.0	1.788	72.06	40.3	1.896	72.12	38.0	1.580	62.41	39.5	1.611	61.86	38.4
1947	1.237	49.97	40.4	1.473	59.36	40.3	1.566	62.95	40.2	1.636	66.59	40.7	1.439	56.12	39.0	1.473	57.45	39.0
1946	1.096	43.82	40.4	1.307	52.96	40.5	1.415	56.75	40.1	1.401	58.03	41.6	1.291	48.25	37.9	1.332	50.22	37.8
1945	1.023	44.39	43.4	1.197	54.34	45.2	1.276	56.39	45.9	1.240	52.25	42.3	1.188	52.44	44.1	1.256	51.99	41.3
1944	1.019	46.06	45.2	1.151	53.27	45.4	1.250	58.18	46.6	1.186	51.27	43.4	1.167	54.03	46.3	1.270	57.83	45.5
1943	.961	43.14	44.9	1.100	47.85	42.6	1.201	53.49	44.5	1.139	41.62	36.6	1.124	49.77	44.3	1.234	56.94	46.3
1942	.853	36.65	42.9	1.014	40.35	39.0	1.128	43.99	39.1	1.059	35.02	32.9	1.030	41.67	40.2	1.169	51.94	44.4
1941	.729	29.58	40.6	.934	36.37	37.9	1.034	38.02	37.0	.993	30.98	31.1	.953	37.18	39.0	1.042	41.35	39.6
1940	.661	25.20	38.1	.881	34.03	37.8	.974	34.96	36.1	.883	34.71	38.1	.851	31.49	37.0	.948	35.70	37.7

* Figures for November, latest available. [1] Includes steel works and rolling mills. Source: Bureau of Labor Statistics.

candidate for Phil Murray's job is Phil Murray. He always has been and continues to be. That story of my wanting to take over the CIO is an old one that's been circulated for years.")

Knight could be taken at his word without doubting his candidacy. Murray is not in the best of health, may soon retire.

Companies Stand

The oil companies' stand in this dispute was typified by a Gulf Coast firm which was quick to grant pay hikes in the fall of 1950 and the spring of 1951 when they became permissible under Wage Stabilization Board Regulation No. 6. Another increase was offered when WSB order No. 8 noted further advances in the cost of living.

Beyond this the company would not budge, holding that a proposal for an increase in excess of that allowed would have required it to join with bargaining agencies in petitioning WSB to break its wage formula, "thus contributing to inflation."

In further emphasis of its reluctance to become an inflationary bellwether, the company added that if the "wage stabilization program is changed, the company will be prepared . . . to discuss the wage question further."

None doubted this, but it was not enough. It was not enough for Jack Knight, whose law-defying 25-cent demand carried the surety of government action, and it was not enough for the 275,000 oil workers now actively or sympathetically embroiled.

The workers' arguments were summarized for WORLD OIL in the plain language of a plain man who had been described by a refinery official as "a union man but a company man."

Relaxed and at peace in the living room of his friendly home, it seemed paradoxical that this solid American citizen typified the marching hordes who could have such a tremendous impact on the national economy. But as he paraphrased the union argument (hidden cost, ability to pay, increased taxes, increased productivity) there could be no doubt he would go all the way with Jack Knight.

"We've had raises, but not enough . . . This new 4.6 percent raise being offered wouldn't pay the difference in our tax increases since 1950 . . . Something's got to be done, and looks like it won't be done without economic pressure . . . DiSalle tried, I guess, but things keep going up . . . The oil companies want more for their products, don't they? Why shouldn't we want more for our labor? . . . Yes, I realize that people with fixed incomes are going to get it in the neck. My mother draws a pension. . . . I'm sorry for all of them. Still, you can't blame a man for trying to make a decent living."

Whether this man's reasons for striking were merely Knight's excuses for calling the strike was known only to Knight himself, an able man whose plans bore the perfection of great patience. But the signs were many that an immediate pay hike was not Knight's sole objective or his most important objective.

The union has long sought, and the industry has as long resisted, nationwide bargaining rights. Because of progressive labor-management policies oil is the only major industry in the U. S. which does not have a nationwide bargaining organization. Aside from the great labor rift of 1945, oil labor strife has been limited to individual company or plant strikes and the California strike of 1948. OWIU has a nationwide contract with only one major oil company.

That the union realized the necessity of reaching this nationwide bargaining goal before it could attain the stature of the steel and auto workers is emphasized repeatedly in "History of Oil Workers Union-CIO," a book published in 1950 by OWIU, written by Harvey O'Connor, long-time CIO stalwart, and sanctified by a foreword from Knight. "The senseless duplication in bargaining at each plant must be ended," O'Connor wrote. And again: "National bargaining is essential in establishing rates and conditions."

O'Connor also seems to make it plain how the union intended to win national bargaining rights: "By now it is obvious that no company will follow voluntarily the lead given by the union and Sinclair in demonstrating that national bargaining can be mutually advantageous. Pressure will be needed, and will be applied until the goal is achieved."

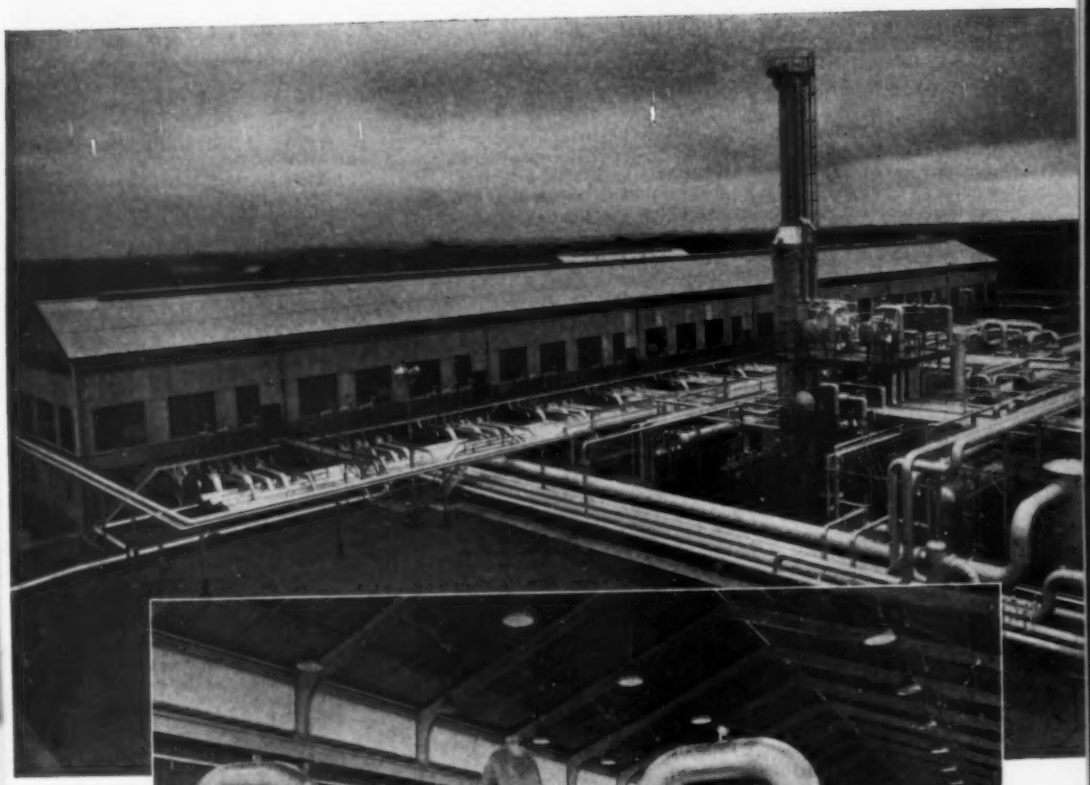
Popular Issue Chosen

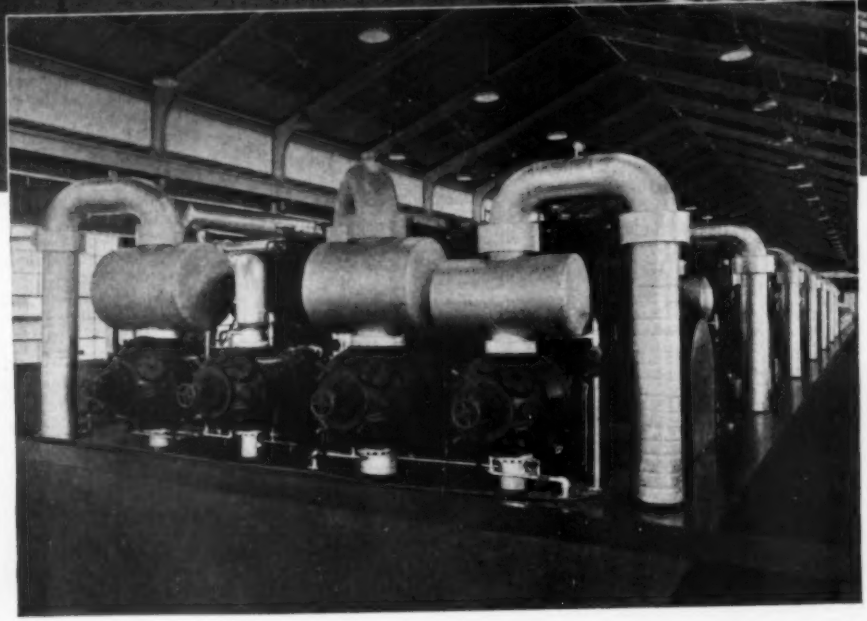
In mustering this pressure for a showdown, OWIU was saddled with the handicap of a membership that totaled only about 110,000 of the nation's approximately 650,000 oil workers. This was overcome by setting up a 25-cent wage demand which was more than the workers had dreamed of, more than the independent unions would ask, more than the government would allow under existing laws, and more than the companies could grant.

Independents who had previously resisted the overtures of OWIU as being of no advantage to them flocked to OWIU's rallies at St. Louis, where the 25-cent campaign was adopted; to Kansas City, where strike strategy was set; and to Denver, where the strike deadline was named.

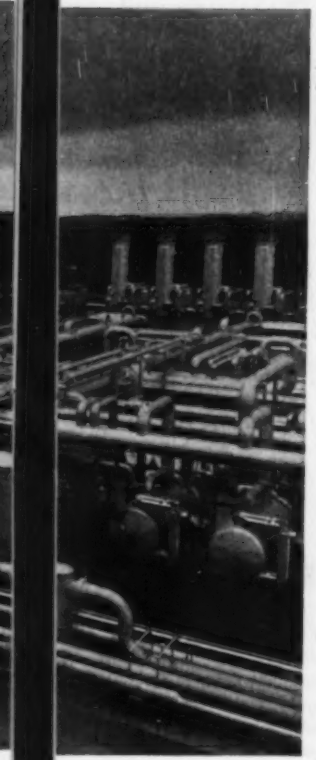
Now the OWIU could claim the active or passive support of 275,000, including 22 independent and AFL craft unions. It had at last achieved unity. Unavoidable that the U. S. public would have small sympathy for a strike during these times by some of the highest-paid workers in America; and it mattered little that the oil companies would fight back. The 25-cent demand had lifted the issue above the companies and into the hands of a sympathetic government.

Clark "Big Angles"





score another first!



Clark HBA Compressors, Famed for Sustained Fuel Economy and Dependability, Installed in World's Largest Ethane Recovery Plant

Tennessee Gas Transmission Company recently placed in service the largest ethane recovery plant ever built for operation in conjunction with a gas transmission pipeline. In designing the Gabe, Kentucky plant, process requirements dictated the following rigid compressor specifications:

- A total of 23,000 horsepower required
- 1600 to 1800 horsepower units were necessary for proper compressor distribution between the five compression services
- 750,000,000 cubic feet per day capacity
- Four compressor cylinders per unit
- Minimum fuel consumption was necessary because overall economics indicated an "end of the line" high fuel cost, plant location

With over 135,000 horsepower of Clark BA and HBA compressors already operating in their other compressor stations or on order, Tennessee Gas Transmission Co. knew first hand what the "Big Angle" could do. Thirteen Clark 1760 BHP, High Compression "Big Angles" were subsequently installed to handle all compression services in the new plant. These services include propane refrigeration, ethane refrigeration, reactivating gas service, flash gas service and the return of residue gas to the pipeline.

If you are contemplating building a plant involving intricate processing operations, consult your nearest Clark representative. He has the compressor know-how and a complete line of heavy duty compressor equipment to simplify your installation.

For complete details on Clark Big Angles request Bulletin 104

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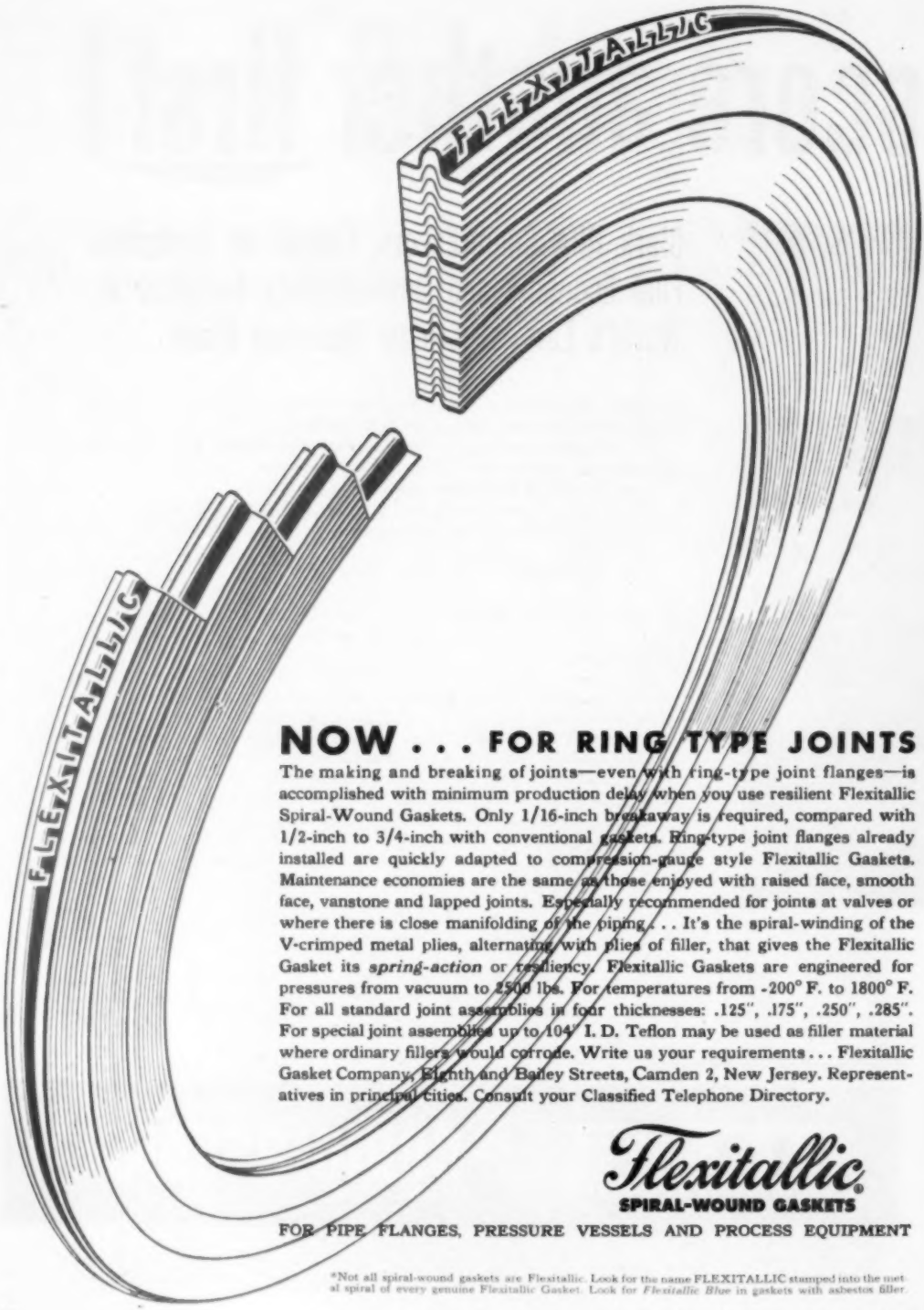

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The making and breaking of joints—even with ring-type joint flanges—is accomplished with minimum production delay when you use resilient Flexitallic Spiral-Wound Gaskets. Only 1/16-inch breakaway is required, compared with 1/2-inch to 3/4-inch with conventional gaskets. Ring-type joint flanges already installed are quickly adapted to compression-gauge style Flexitallic Gaskets. Maintenance economies are the same as those enjoyed with raised face, smooth face, vanstone and lapped joints. Especially recommended for joints at valves or where there is close manifolding of the piping. . . It's the spiral-winding of the V-crimped metal plies, alternating with plies of filler, that gives the Flexitallic Gasket its *spring-action* or resiliency. Flexitallic Gaskets are engineered for pressures from vacuum to 2500 lbs. For temperatures from -200° F. to 1800° F. For all standard joint assemblies in four thicknesses: .125", .175", .250", .285". For special joint assemblies up to 104" I. D. Teflon may be used as filler material where ordinary fillers would corrode. Write us your requirements . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey. Representatives in principal cities. Consult your Classified Telephone Directory.

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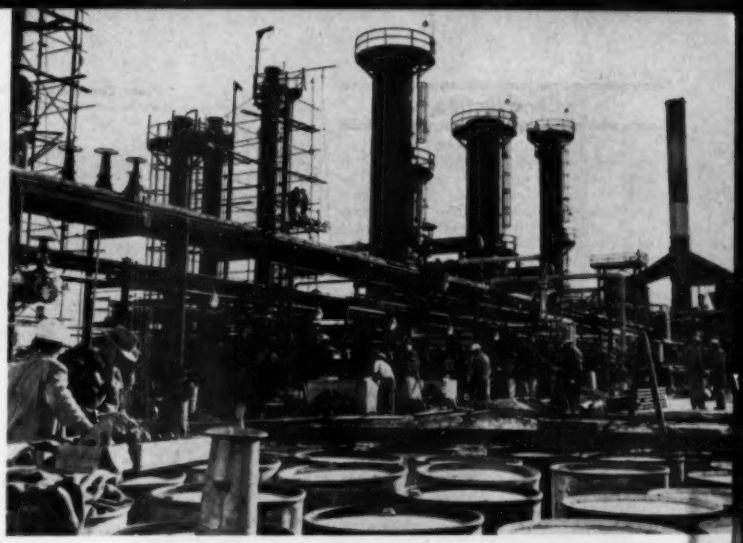

NEW UNIT OPENED—Eastern States Petroleum Company, Houston, enters the petrochemical field with the new Platformer unit shown above in conjunction with an Aromatic Recovery Unit. Completed in a record time, the new units were inaugurated by the company on February 28 with an informal reception and a plant inspection the following day.

—Photo Courtesy Eastern States Petroleum Co.

Pure Erects World's Largest Orthoflow Unit in Texas

Two of the largest Orthoflow fluid catalytic cracking units ever built will be erected by The M. W. Kellogg Company at Toledo, and Smith's Bluff, Texas, as part of the Pure Oil Company's expansion and modernization program at these two refineries. The Texas cracking unit will have a capacity of over 26,000 barrels per day, and the Ohio unit will have a capacity of 17,000 barrels.

In addition, Kellogg will erect a light ends recovery system, a catalytic polymerization unit and sulfur removal equipment at Toledo. At Smith's Bluff, Kellogg will build a new 20,000-barrel-per-day vacuum feed preparation unit, a catalytic polymerization unit similar to the one at Toledo, a light ends recovery unit, sulfur removal equipment and will revamp the thermal cracking facilities. Construction at both plants is underway.

PAD Approves California Standard Synthetic Plant

Government approval has been obtained for a synthetic phenol plant at Richmond, to be erected by Standard Oil Company of California, with certification covering 50 percent of the new plant's process facilities, and 45 percent of auxiliary facilities.

All research necessary to operation of the plant has been completed, and design work is approaching completion. This plant will be the first synthetic phenol plant in the west and using a recently-developed synthesis process in which neither sulfuric acid nor chlorine is used, will produce phenol and acetone for Standard's subsidiary, Oronite Chemical Company. Construction of the new plant will start soon.

Imperial Oil Modernizing And Expanding Regina Plant

Modernization of the Imperial Oil Limited, refinery at Regina, Saskatchewan, will cost about $7 million and will increase the plant capacity by 2500 barrels daily when completed early in 1954. New units to be installed include an 8100 barrel daily vacuum pipe still, a 7500 barrel fluid catalytic cracking unit, a light ends plant and treating facilities, steam generating equipment and additional storage plants. The plant originally was put on stream in 1916 with a capacity of 1500 barrels daily.

Second Company Announces Plant in Williston Basin

The second refinery announced for the Williston basin has been scheduled for construction by the Williston Refining Company. James P. Dunnigan, Producers Refining, Inc. of West Branch, Mich., is heading the new company which will erect a 10,000-barrel refinery in North Dakota at a cost of $5 million. The plant will include topping, vacuum and platforming facilities and will be started when the Petroleum Administration for Defense certifies the project.

News Notes On Refinery and Other Plant Construction

Petroleum Refiner's quarterly "Box Score" tabulation next appears in the April issue

Altona, Australia, Plant Slated for Completion 1955

Further expansion of the Standard-Vacuum Oil Company's Altona refinery near Melbourne, Australia, calls for an eleven-fold increase in capacity and an additional investment of $30 million. The new program represents nearly a 50 percent jump in plant size and investment over original expansion plans reported last August. The present crude-running capacity is 1800 barrels per day to compare with 22,000 barrels to be effected by the expansion.

With facilities scheduled for completion in 1955, Altona will be, in effect, a complete new refinery located on property adjoining the existing plant. Crude distillation, catalytic cracking, reforming, and treating facilities will be included in the construction.

Preparation Underway On Davison Catalyst Plant

Preliminary construction was begun in February on the plant which The Davison Chemical Corporation of Baltimore will build ten miles south of Lake Charles on the Calcasieu River in Louisiana. To cost more than $7 million, the plant will produce catalyst on a large scale for the petroleum-cracking refineries of the Gulf Coast area, and other chemicals needed by the industries of the section. The Consolidated Engineering Company of Baltimore, general contractors, will supervise construction.

El Dorado Expansion Plans Move Into Design Stage

Lion Oil Company has announced a $5 million expansion program at its refinery in El Dorado, Ark, to supplement existing manufacturing and operating facilities. T. M. Martin, company president, said that contracts are in preparation covering the design and construction of new process units which will include a fluid catalytic cracking unit with integral vapor recovery equipment and a 1150 barrel-per-day sulfuric acid type alkylation plant. The cracking unit will have daily capacity for 5000 barrels of fresh charge plus a like quantity of recycle charge.

This expansion will permit an increase of approximately 50 percent in gasoline yields and a reduction in output of lower profit items such as fuel and burner oils. The refinery also will be in better position to supply higher octane fuels when the new units go into operation late in 1953. Refinery thruput will be increased to 23,500 barrels of crude oil daily.

Brazilian Refinery Gets 25,000 Barrel TCC Unit

One of the largest Thermofor catalytic cracking units built to date, with a nominal capacity of 25,000 barrels a day, is under construction for a private corporation in Brazil under license from Socony-Vacuum Oil Company, Inc. The TCC is of airlift design and is only one unit in a refinery being built at Capuava by Refinaria E Exploracao de pe-

troleo Uniao S.A., an enterprise capitalized at $16.5 million and headed by Alberto and Bento Soares Sampaio, brothers with large industrial interests in Brazil. Hydrocarbon Research, Inc., of New York City, is contractor for the project.

Esso Enlarges Expansion Plans at Baton Rouge, La.

Expansion by $16 million of a construction program announced last October, has been announced by Esso Standard Oil Company for its Baton Rouge, La., refinery. The greater expansion will include new distillation units and expansion of fluid catalytic cracking facilities. Additional equipment for chemical-treating, blending and shipping facilities will be included. With completion scheduled within 24 months, the Baton Rouge plant will show a capacity increase of 135,000 barrels crude per day over 270,000 barrels daily processed before.

Sunray Begins Refinery At Corpus Christi, Texas

Immediate construction of a new 28,000-barrel-per-day catalytic cracking refinery at Corpus Christi, Texas, has been announced by Sunray Oil Corporation. The construction contract was signed in Tulsa by Floyd L. Martin, Sunray vice president, and J. F. Thornton, president of The Lummus Company. Lummus will handle the project, scheduled for completion in late summer 1953, from their Houston office. The new refinery will operate in conjunction with Sunray's crude oil gathering and deep water tanker and barge terminal facilities in the Corpus Christi area.

Universal Oil Products, Chicago, will design the fluid catalytic cracking unit, alkylation and catalytic polymerization plants. The crude distillation and treating units will be engineered by Lummus.

Plant Construction Allowed Fast Tax Writeoffs

COMPANY and LOCATION	Type of Facility	Amount Amort. Applied For	Amount Certified	Percent Allowed
Socony-Vacuum Oil, Paulsboro, N.J.	Motor fuel and Aviation Gasoline	$ 6,677,000	$5,955,000	65
			722,000	45
Ashland Oil & Refining, Catlettsburg, Ky.	Aviation Gasoline	4,500,000	1,965,000	65
			1,475,000	90
			585,000	45
Standard Oil of Ohio, Lima, Ohio	Products Storage	4,985,000	250,000	40
Shell Oil, Wood River, Ill.	Petroleum Storage	1,618,000	542,000	40
Shallow Water Refining, Scott County, Kan.	Gasoline	349,584	85,000	65
Phillips Petroleum, Phillips, Texas	Aviation Gasoline	12,989,630	9,485,630	90
			45,000	65
			2,344,000	45
			550,000	15
E. I. duPont de Nemours, Orange, Texas	Polyethylene	10,293,000	10,293,000	60
Union Carbide & Carbon, Texas City, Texas	Polyethylene	17,694,200	16,604,200	60
Universal Oil Products, Mooringsport, La.	Platforming Catalyst	2,100,000	1,415,000	75
			590,000	50
			67,000	15
Universal Oil Products, Mooringsport, La.	Synthetic Cracking Catalyst	2,000,000	1,555,100	75
			384,300	50
			60,600	15
Shamrock Oil & Gas, Sunray, Texas	Aviation Alkylate	2,444,420	2,086,695	90
			352,225	50
Taylor Refining, McAllen, Texas	Natural Gas	3,920,090	3,871,521	65
Mayfair Minerals, Inc., McAllen, Texas	Natural Gas	3,920,090	3,871,521	65
Texas Natural Gasoline, H. W. Bass & Sons, Tulsa, Okla.	Butanes	565,243	159,830	40
			376,413	65
Ethyl Corporation, Baton Rouge, La.	Tetraethyl Lead	150,000	150,000	65
South-Tex Corporation, Nueces County, Texas	Gasoline, Propane, Butane	1,081,100	160,900	40
			920,200	65
Caminol Company, Hanford, Calif.	Motor Gasoline, Distillates	250,709	35,000	65
			35,000	15
General Petroleum, Worland, Wyo.	Sulfur and Process Plant	4,220,000	1,259,000	70
			528,000	40
			2,433,000	65
Honolulu Gas Company	Benzene	270,474	243,427	90

Petrochemical Operations To Promote Canadian Growth

Canadian industry as a whole is looking to the operation of the Canadian Chemical Company Ltd. petrochemical plant at Edmonton to speed industrial growth by stimulating the development of new process methods and encouraging the location of new industries. Expected to be on stream during the fourth quarter of 1952, the plant will produce an impressive list of chemicals and will manufacture products specifically needed by Canadian industry.

Du Pont Starts Texas Plant

Groundbreaking for a new E. I. Du Pont de Nemours and Company petrochemical plant will be started at Beaumont, Texas, early next year. The plant is rumored to be in the $100 million bracket.

SUNRAY CONTRACT—Floyd L. Martin, vice president of Sunray Oil Corporation, signs contract for Corpus Christi, Texas, plant construction. Standing is J. F. Thornton, president, The Lummus Company, New York. See item above.

Pre-Construction Filing Required for Fast Tax Write-Off

A major change in the regulations governing issuance of certificates of necessity for rapid tax amortization was made by Defense Production Administration effective March 1. Under the new rules applicants for such certificates for any type of facility are required to file for the certificate prior to starting construction. Heretofore applications could be filed after construction commenced.

Due to the increasingly tight supply of critical materials DPA said such predetermination of construction programs where fast tax amortization is applied for is necessary for the government agency to view applications based on the shortages of existing production facilities and the essentiality of the product or service involved.

After initial determination is made under the new regulation that a shortage of facilities exist for an essential product then the percentage of certification (the portion of the over-all cost of a project allowed for accelerated write-off) is determined considering probable economic usefulness of a particular facility after five years and the minimum incentives deemed necessary to obtain the needed expansion of facilities.

Factors which DPA considers in making this determination include:

1) The character of the business, including the source, amount and nature of the materials required for expansion and the product or service provided.

2) The manufacturing or servicing processes involved, normal depreciation rates and expansion in competitive fields.

3) The extent of risk assumed, including the amount and source of capital employed, the potentiality of recovering capital and retiring debt through tax savings or pricing, the relative expansion needed, the economic consequences

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of the location of a facility due to security or other emergency factors, increased costs due to expedited construction, and the historical background of the industry.

4) The extent to which the facility is being or will be used in lieu of existing facilities.

While applications for certificates of necessity on all construction and permanent installations, regardless of estimated costs, must be filed before the start of construction, a project estimated to cost less than $100,000 exclusive of land costs, may be started upon the filing of an application for a certificate of necessity without prejudicing eligibility for the accelerated tax write-off. Applications for certificates of necessity on equipment which will not become a permanent part of any building, structure or other real property may be filed not later than six months after the date of acquisition.

Houston Site of Further Petrochemical Building

A petrochemical plant costing between $1.5 and $2 million will be erected for Diamond Alkali Company in the Deer Park area near Houston. Brown & Root, Inc. has been contracted to build the inorganic plant. Existing caustic soda facilities will be expanded also in the construction program.

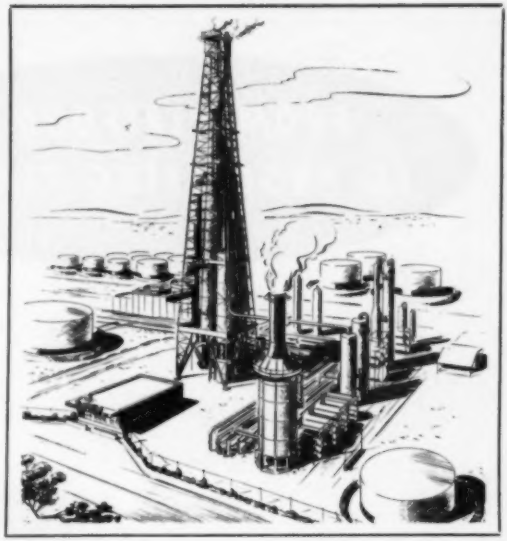
J. S. Fluor Now President Of Fluor Corporation, Ltd.

J. S. Fluor has been named president of Fluor Corporation, Ltd., Los Angeles engineers, constructors, and manufacturers. D. W. Darnell, former president, has been elected chairman of the board. Darnell replaces Shirley E. Meserve, senior partner of Meserve, Mumper and Hughes, Los Angeles law firm, who will continue as chief counsel and member of the board. J. Robert Fluor becomes executive vice president, a post formerly held by J. S. Fluor. James P. Wiseman, vice president, and Francis E. Fischer, secretary-treasurer, were re-elected.

Fluor's new president is the son of J. Simon Fluor, founder of the firm. He joined the company in 1921, and since 1944 he has served as executive vice president.

The company shortly will open an office in Toronto, Canada. It moved into a new building March 1 at Houston, Mid-Continent Division headquarters.

CONTRACT LET—A packaged-type TCC unit, pictured herewith, will be built at Potwin, Kas., for Vickers Petroleum Company. See item below.



Cleveland Miniature Plant Eliminates Costly "Bugs"

A crude unit scale model built by the Industrial Model Company of Delaware has aided in eliminating construction "bugs" since being commissioned by The Standard Oil Company (Ohio) and McKee Company at Cleveland. Costing $3500, the model is an exact duplicate, complete to the most exacting standards, of the twin crude oil distillation units at Standard's No. 1 plant at Cleveland.

AIOC Buys Schindler Interest

Recent purchase by the Anglo-Iranian Oil Company of the Julius Schindler Oil Company refinery at Neuhof, Germany, is being followed up by a $2.8 million expansion program which will get started soon. By 1953 the plant will have a rated capacity of 4000 barrels daily. It also acquired the Schindler refinery at Peine.

Imperial Oil to Expand

An expansion program at Vancouver, British Columbia, has been announced by Imperial Oil Company Limited, to increase the 12,000-barrel capacity to 22,500 barrels a day.

Vickers Schedules TCC Unit for Kansas Refinery

Southwestern Engineering Company of Los Angeles will design and erect a 6000-barrel-daily catalytic cracking unit and auxiliary facilities for Vickers Petroleum Company at Potwin, Kans. A SWECO packaged type TCC unit developed by Southwestern and Socony-Vacuum Oil Company will be installed, with completion scheduled within the next 12 months. The existing crude distillation unit and thermal cracking unit will remain intact; catalytic feed preparation, vacuum distillation, catalytic cracking, gas recovery unit, revamping and the expansion of existing catalytic polymerization units will be included in the program.

Standard-Indiana Plans Williston Basin Refinery

Standard Oil Company (Indiana) considers the Williston Basin such a promising source of crude oil that it intends to build a new 15,000 barrel-per-day refinery in North Dakota, designed so that it could be expanded to run at least 30,000 barrels per day as crude production and market demand for products increased. A definite site will be selected soon, and while engineering work has already been started, construction probably cannot begin until 1953.

Sulfur Unit Begins Operations

About 9000 tons of sulfur will be extracted from hydrogen sulfide annually at first sulfur extraction plant in operation in Canada. Located at Jumping Pound, Alberta, the plant is owned by Shell Oil Company of Canada.

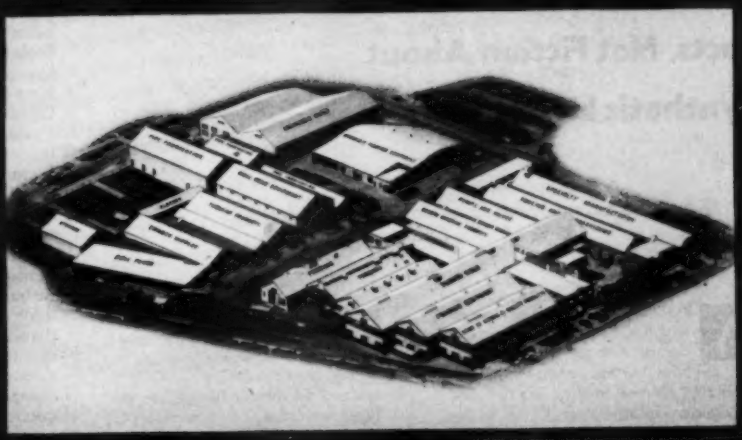
Building Denver Cracker

Procon, Inc. has begun construction of a second catalytic cracking unit at Bay Petroleum's Denver plant. A new UOP fluid catalytic cracking unit was recently completed by Procon at Chalmette, La., and is on stream producing high octane gasolines.

TOP MANAGEMENT—J. S. Fluor, center, new president of Fluor Corporation, Inc., is shown conferring with D. W. Darnell, left, chairman of the board, and J. Robert Fluor, executive vice president. See accompanying item.

70 YEARS' SERVICE

70 YEARS



NORRIS

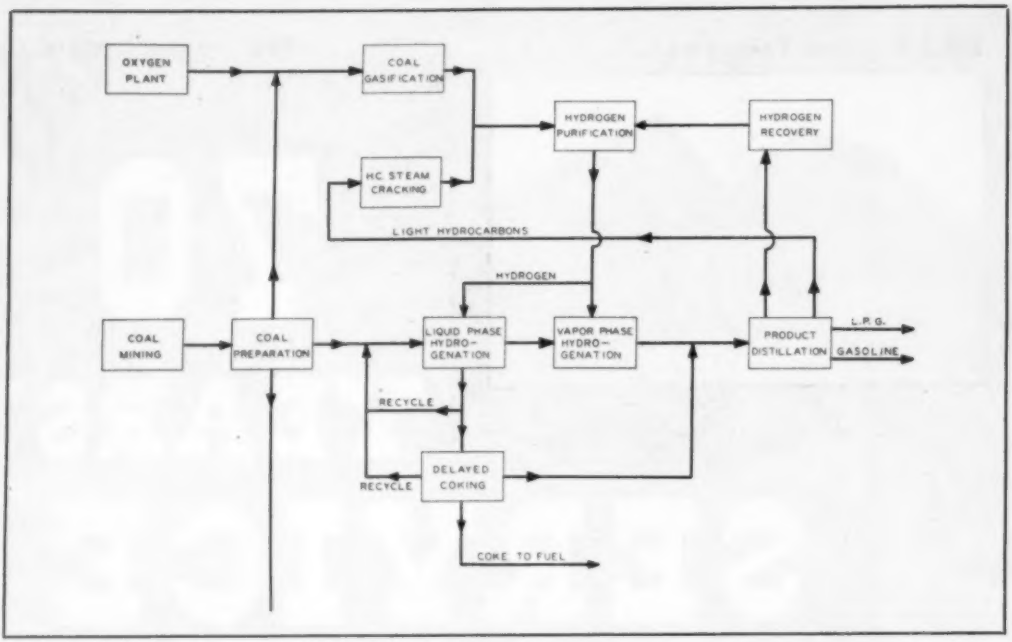


Figure 1. Coal Hydrogenation Flow Diagram.

Facts, Not Fiction About Synthetic Liquid Fuels

PAUL R. SCHULTZ
Manager, Economics Department, Stanolind Oil and Gas Company, Tulsa.

FOR SEVERAL years now, considerable publicity has been given the synthetic liquid fuels problem with most of the favorable comment emanating from the U. S. Bureau of Mines Office of Synthetic Liquid Fuels, an office which maintains that the costs of manufacturing gasoline from coal or oil shale are less than those currently being encountered in the normal processing of petroleum. The Bureau also maintains that the nation is running out of crude oil and that synthetic fuels must be pushed. Some of the fog created by these Bureau statements is clarified in the accompanying article which presents findings of industry experts who made careful studies of the matter.

ABOUT two years ago the petroleum industry became concerned with the synthetic liquid fuel publicity being released by the Bureau of Mines and initiated several studies in this regard. All of the studies carried out by industry indicated that costs of synthetic liquid fuels were considerably higher than those encountered in the normal practice of liquid fuels manufacture. The petroleum industry, however, did not decrease its research work on synthetic liquid fuels and has never recommended that the U. S. Bureau of Mines diminish its efforts in this regard. The petroleum industry recognizes that if and when crude oil becomes a scarce commodity, alternate sources of liquid fuels must be found, and are preparing for such an eventuality. The petroleum industry unanimously, however, sees no indication that such a day is imminent.

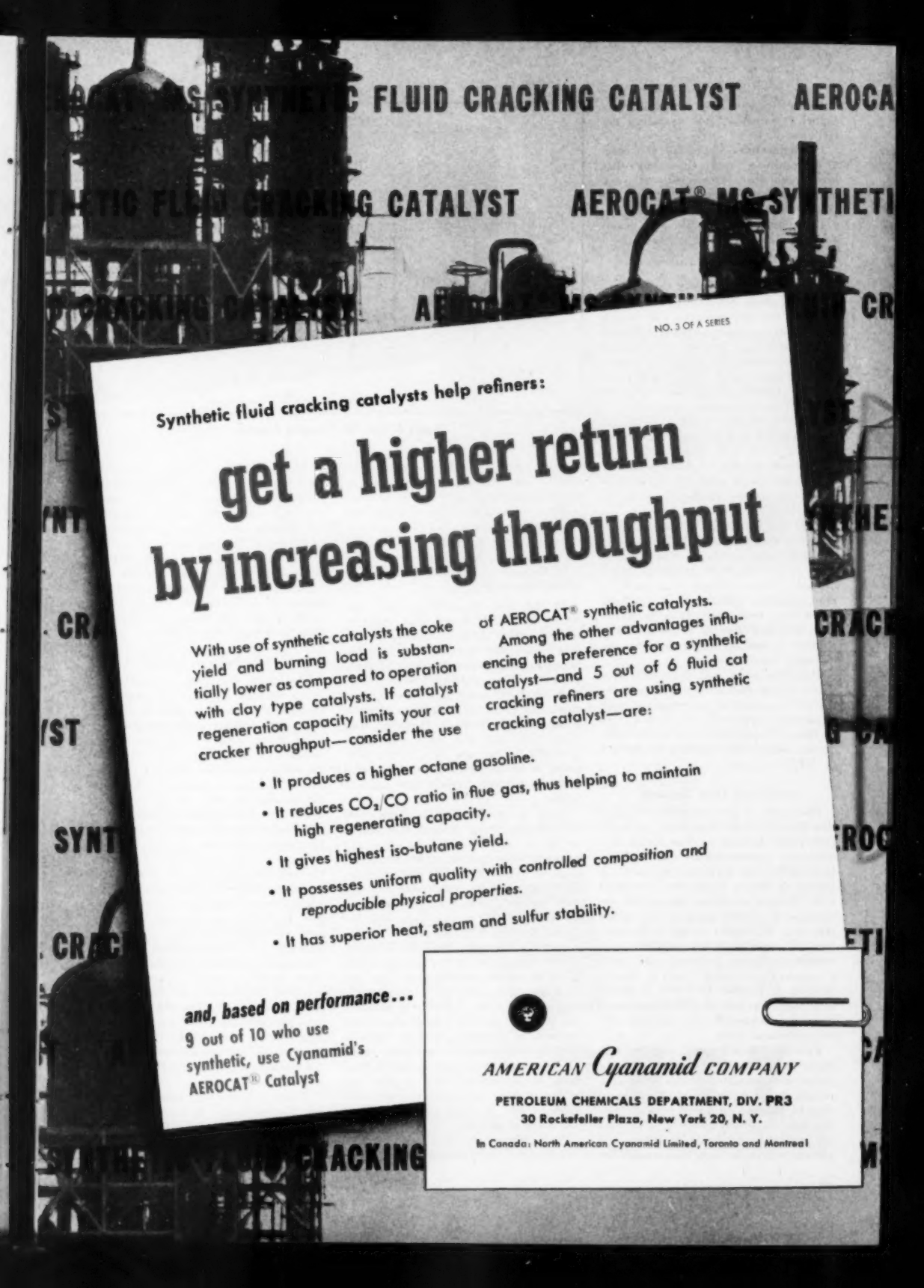
Because of all the conflicting information being publicized, the Secretary of the Interior in April, 1950, requested that the National Petroleum Council create a committee to:

1) Review estimates made by the U. S. Bureau of Mines of the costs of producing synthetic liquid fuels,
2) Prepare independent cost estimates, and
3) Make recommendations as to ways and means, if any, for improvement of future cost estimates of the U. S. Bureau of Mines.

NPC created such a committee and this work was undertaken in June, 1950. Subcommittees were organized to cover the following:

1) **Raw Materials**—Concerned with the costs of mining, both investment and operating; and with the location of sites on the basis of sufficient reserves and water availability.

2) **Process**—Examine the process data to determine the operability of the vari-



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Among the other advantages influencing the preference for a synthetic catalyst—and 5 out of 6 fluid cat cracking refiners are using synthetic cracking catalyst—are:

- It produces a higher octane gasoline.
- It reduces CO_2/CO ratio in flue gas, thus helping to maintain high regenerating capacity.
- It gives highest iso-butane yield.
- It possesses uniform quality with controlled composition and reproducible physical properties.
- It has superior heat, steam and sulfur stability.

and, based on performance...
9 out of 10 who use synthetic, use Cyanamid's AEROCAT® Catalyst

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ous steps chosen; also estimated personnel requirements for operating the facilities.

3) **Engineering**—Estimated the costs of equipment to be provided and other investment costs connected with the project; assisted in development of operating cost factors.

4) **Economics**—Assemble and evaluate the process designed and engineered by the other groups.

Care of Study

An idea of the complexity of the problem and the thoroughness with which the project has been studied is indicated by the following: Number of members of subcommittees, 47; additional technical personnel used, 105; total miles traveled, 400,000; dollars spent, $300,000; and outside companies consulted, 115.

These statistics for work done on coal hydrogenation and oil shale and are incomplete in that they do not include the last several months of work. Study on the production of synthetic liquid fuels from coal via the Fischer-Tropsch reaction is still underway.

NPC utilized the best technical personnel available within the industry in its study, and assistance was obtained from experts in other industries where needed. Never before has such a thoroughgoing evaluation of synthetic liquid fuels been made. It is inconceivable that any figures developed in a studied evaluation could deviate significantly from these.

This discussion will deal with synthetic liquid fuel costs developed by the NPC committee as compared with those costs reported by the U. S. Bureau of Mines. Comments are the author's and do not necessarily represent the opinion of NPC.

Additional Data Required

The work of the committee required considerably more time than originally anticipated because it was found that necessary process design data had not been sufficiently developed by the U. S. Bureau of Mines. Much time was spent with Bureau of Mines personnel developing this additional and very necessary data. In respect to coal hydrogenation, this data were not available even though the Bureau had previously issued a supposedly complete report in August of 1949, R. I. 4564. However, it should be brought out that all USBM personnel were most cooperative in assisting with this additional work.

Results of this detailed and thorough study were finally submitted to the parent subcommittee in the form of a report of some 550 pages. This report showed that the estimated cost of gasoline from shale was about 1$ or 16 cents per gallon as produced, including a 6 percent return on total investment but

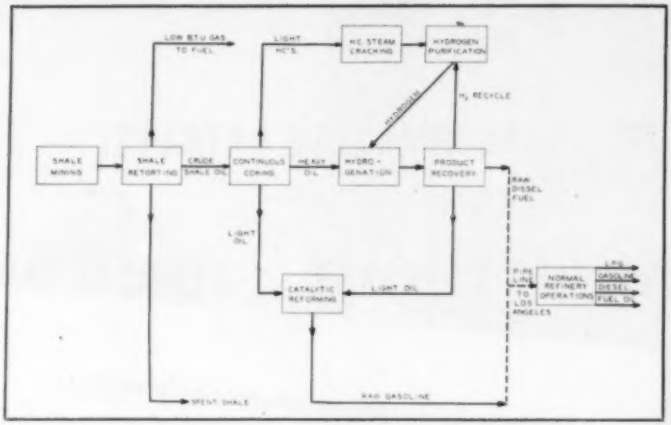


Figure 2. Shale Oil Processing Diagram.

no selling or transportation expense. The cost of gasoline from coal hydrogenation was estimated to be about 40 cents a gallon on the same basis as above. An explanation of the use of the 6 percent return, which incidentally has caused some confusion, and a breakdown of the NPC investment and operating expense will be discussed later.

At the time the NPC report was issued the USBM issued what might be termed a rebuttal on coal hydrogenation, that is, a report showing that they believed the cost should be about 11 cents per gallon. They proceeded to take issue with the NPC report and indicated that the costs given were far in excess of what might be realized. However, they found little fault with the cost on shale, probably because the NPC results indicated it to be much nearer to being competitive with present-day gasoline prices.

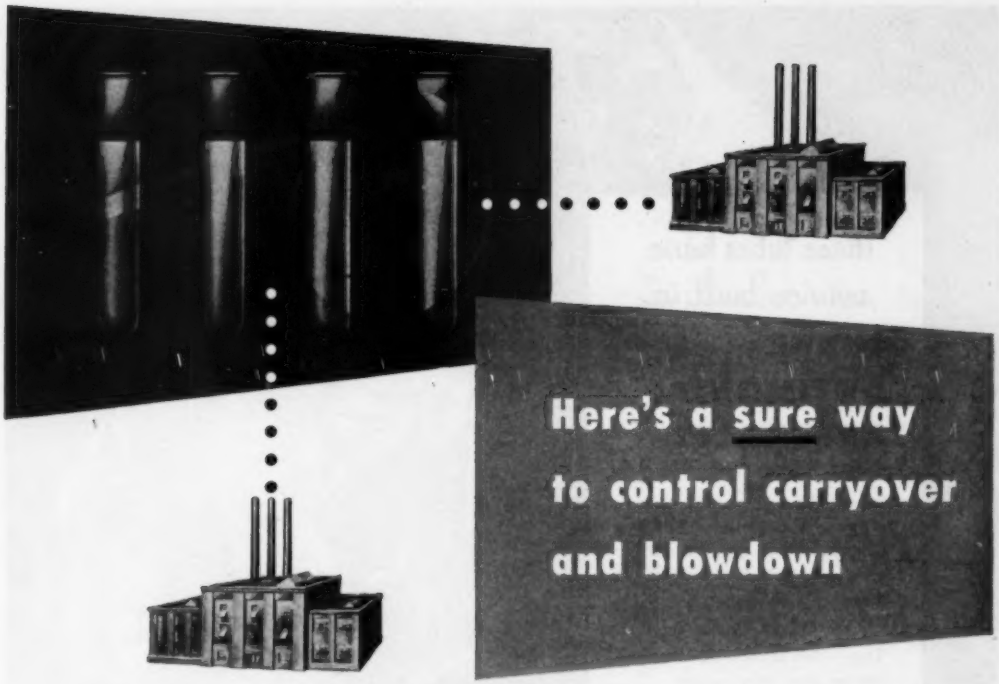
Since no recent USBM figures are available for shale oil cost, this article, as far as details go, will be concerned primarily with coal hydrogenation. Plant location will be limited to Rock Springs, Wyo., so as to be comparable with the only recent USBM study available. As far as the actual process goes, it is believed that the NPC and USBM are on essentially the same basis. Accordingly, a brief description of the process at this point would be enlightening. The coal hydrogenation process, as presently sponsored by the USBM, is basically the same process that was developed and utilized in Germany, and no material process improvements have been made. Certain mechanical improvements have been incorporated in the process, but many of these improvements were recognized, and in some cases utilized, in the German process.

The estimates for coal hydrogenation are based on the assumption that coal is available in sufficient quantity, at a minable depth and thickness, and at a location having water required for the operations. The coal is prepared for hydrogenation by cleaning and crushing operations which reduce the ash content to as low a value as practical and to a size suitable for hydrogenation. The cleaning and crushing produce a large amount of higher ash and otherwise off-grade coal which is used for steam generation and other heat duty (Figure 1).

Liquefication Process

The clean fine coal is mixed with heavy recycled oil from the process to produce a paste. This paste is charged to the liquid phase hydrogenation operation along with a small amount of catalyst. At a pressure of about 10,000 psi and a temperature of 900° F., a large part of the coal is liquefied. The material leaving this stage of the process is distilled to obtain a light oil and a heavy oil. Part of the heavy oil is recycled to the pasting operation and the remainder is coked to provide a means of rejecting the ash and used catalyst. In a second stage, the light oil is hydrogenated over a fixed bed of catalyst at 10,000 psi and 900° F. to yield gasoline and LPG. Certain chemicals (phenols, cresols and xylenols) can be recovered from the first-stage product. Conventional petroleum refining procedures are used for the final treatment of the products into gasoline and LPG. The USBM scheme was basically the same with the exception that in their study the aromatic compounds, benzene and toluene-xylene, were removed as products from the gasoline streams.

Figure 2 shows the process developed for the production of liquid fuels from oil shale. Despite all USBM claims as to the developments which they have made in the art of processing oil shale,



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most of the processes developed have resulted from industry work. Both the retort and the refining method for crude shale oil chosen by the Bureau were developed by industry. The only developments contributed by the Bureau were those involved in mining operations where they accomplished novel application of equipment being used in other type mining. It will be noted that shale, after being mined and crushed to a suitable size, is charged to a retort. This retort has been described in the literature, and the particular retort utilized in the latest studies has been that designated as the Union Oil Retort. This retort operates on the up-flow principle, that is, shale is fed at the bottom of the retort and the flow of gas is downward through the retort. The crude shale oil produced is charged to continuous coking, at which point three streams are taken off. The light gas oil is charged to catalytic refining. The heavy oil is charged to hydrogenation, and the light hydrocarbons go to steam cracking for the production of hydrogen which is utilized in the hydrogenation step. The light hydrocarbons, via the hydrogenation step, are also charged to the catalytic refining, and two raw streams are produced from the plant which are designated here as raw gasoline and raw diesel fuel. In the oil shale process, gasoline was shipped via pipe line to Los Angeles where normal refinery operations produce motor fuel, diesel fuel, fuel oil, and LPG.

Comparison of Prices

Table 1 shows the products and prices used in both the NPC study and the USBM rebuttal on coal hydrogenation. First of all, the differences in the plant sizes should be noted. The USBM is entirely too optimistic in this respect. Possibly part of the equipment in the USBM study will handle the 30,000 barrels per calendar day but the NPC found that most of it is only of a 27,000 barrels per calendar day size. It will also be noted that while the amount of liquid fuels are about the same, there is considerable difference in the by-product chemicals. The NPC study was concerned only with making the maximum amount of liquid fuels, therefore, the benzene and toluene-xylene cuts were left in the gasoline. The yields used by the NPC were obtained from the USBM data apparently from selected runs made by them. It is believed that yields are not based on any continuous run for the range of products but rather on individual runs for each product. The NPC was never able to confirm if the larger yields of tar acids used by the USBM were consistent with gasoline quality and yields used. The NPC prices used are plant realization and were arrived at after a thorough market study.

TABLE 1
Coal Hydrogenation Plant, Rock Springs, Wyo.
Raw Material, Products Sold and Prices

	NPC		USBM	
Input, Coal, Tons/CD	12,960		13,350	
Output, Barrels/CD	27,000		30,000	
Production Breakdown	**Units/CD**	**Price**	**Units/CD**	**Price**
Liquid Fuels				
Motor Gasoline, Barrels	19,490		18,550	11.0 cents/gallon
LPG, Barrels	6,390	3.0 cents/gallon	7,100	4.0 cents/gallon
Total Liquid Fuels, Barrels	25,880		25,650	
Chemicals				
Benzene, gallons	.....	.....	32,200	34.0 cents/gallon
Toluene-Xylene, gallons	.....	.....	107,800	29.0 cents/gallon
Phenol, Pounds	85,000	15.8 cents/pound	120,000	16.5 cents/pound
M-P-Cresols, Pounds	111,000	10.5 cents/pound	176,400	16.5 cents/pound
O-Cresol, Pounds	27,000	7.5 cents/pound	18,100	16.5 cents/pound
Xylenols, Pounds	182,000	5.5 cents/pound	68,500	14.5 cents/pound

Prices used by the NPC throughout are below those developed by the USBM. With regard to LPG, the problem of handling 6 to 7 thousand barrels per day in Wyoming will impose a major marketing job, and the figure developed by the NPC is probably too high a value, at least for the first several years of operation. With regard to the chemical prices, the figures developed by the USBM are based upon today's prices for these commodities which are high because of the war-inflated market. In addition, the Bureau neglected to adjust these prices for the freight allowance necessary to reach the marketing centers from this distant source of supply. No price was assigned to motor gasoline in the NPC study, since the necessary selling price for gasoline was developed as the final figure. A market value of about 11 cents per gallon is probably satisfactory, provided it is realized that the influx of this gasoline volume in this area will bring about serious marketing complications.

Table 2 compares the NPC and USBM investment costs for a coal hydrogenation plant at Rock Springs, Wyo. It is obvious from this table that the USBM completely ignored several items which the NPC considered essential to the construction and operation of such a plant. Some of these could possibly be classed as differences of opinion. However, several of the items should be discussed as to the reasoning behind them, while other items are believed to be, from information available from the USBM, in definite error.

TABLE 2
Coal Hydrogenation Plant, Rock Springs, Wyo.
Summary of Investments
(In Millions of Dollars)

	NPC	USBM
Plant Size, Bbl./CD	27,000	30,000
Total Plant	366	356
Construction Housing	7	.....
Coal Mine	13	13
Process Royalties	1	2
Start-Up Expense	19	.....
Working Capital	37	20
Interest During Construction	.....	15
Total Investment Excluding Housing	473	406
Housing for Employees	48	5
General Community Facilities	12	.....
Total Investment	533	411

Plant Investment

The first item believed to be in error is the plant investment of $356 million. The Bureau has alleged that this latest estimate is based on the estimate presented in R. I. 4564, with modifications to three major units. The modified units are 1) liquid phase hydrogenation, 2) vapor phase hydrogenation, and 3) delayed coking. The estimate presented in R. I. 4564 was made by The Bechtel Corporation in 1948. Their investment estimate amounted to $307 million, exclusive of aromatic hydrocarbon extraction and water facilities. Correcting that estimate for the modification to the three units mentioned above yields a figure of $288 million. The current estimate, excluding aromatic separation and water supply, is $332 million, or an increase of 15 percent. This increase is supposed to provide for the rise in construction costs from 1948 to January 1, 1951, and also to provide for an increase in the capacity so as to permit a thruput of 30,000 rather than 27,000 barrels per calendar day.

If, as stated by the USBM, this recent estimate was derived from R. I. 4564 "conventional" plant estimate, including modifications to three major units, some pertinent factors can be obtained from the NPC report. First, the change in the construction cost index would account for a 14 percent increase, or approximately $40 million of the difference. Second, the NPC Engineering Subcommittee determined that the power requirements were greater than those estimated by the USBM and that in excess of $20 million additional cost would be required on utilities. The USBM has admitted the discrepancy in the steam and power load but has not conceded the investment increase. Third, the NPC determined that most equipment had been sized for 27,000 barrels per calendar day, and therefore the total cost should be increased by at least 6 percent to

permit an increase in capacity to 30,000 barrels per calendar day. Summing up these various increases, the original estimate of $288 million should have been increased to about $370 million instead of the $333 million as reported by the USBM. In addition to the factors just discussed, the NPC found other items which in the aggregate would add another $20 million to the $370 million. All together, it appears that the USBM has either ignored some very necessary cost adjustments or else has made major revisions to the process that are not mentioned in the latest report.

Housing Requirements

The next controversial item in the investments is what housing is necessary at the Rock Springs plant. While the USBM has included only $5 million, the NPC has used a total of $67 million for construction housing, employe housing, and general community facilities. The USBM contends that this $5 million will be all that is necessary to assist in expanding established communities in the plant area. They also say public agencies such as FHA should be encouraged to assist with the development of progressive community housing which may become available to plant workers through rental or purchase agreements. They also mention the economic stability of the synthetic fuel plant as an inducement for investment of private capital.

Most of this is not believed to be true, especially in relation to a plant at Rock Springs. The NPC inquired of one of the larger insurance companies as to their attitude toward financing such plant housing. This company replied that the possibility of the community becoming a "ghost town" was of prime importance to them for the following reasons: 1) the plant represents a new industry of unproven earning power when competing with the petroleum industry, 2) because the Rock Springs region does not have, and is not likely to have, other industries with attendant housing demands, and 3) the plant is not of a type, nor in a location near markets and supplies, which offers any likelihood of its being converted to other use if its designed operation should be discontinued. The company would consider the housing only if someone of recognized financial standing assumed full risk of continued operation of the plant.

In addition, the FHA was asked to give their views on possible financing of the housing. Their reply was that they could approve no loans to a project of this kind at the time of construction. Sometime later, they added, after operations were established, and *if* the project seemed to justify, there was a possibility that housing might then qualify for FHA approval.

TABLE 3
Coal Hydrogenation Plant, Rock Springs, Wyo.
Operating Costs and Selling Price of Gasoline as Estimated by USBM

	Millions of Dollars Per Year
Direct Cost	
(A) Coal Mine	12.2
Catalyst and Chemicals	1.8
T.E.L.	0.8
(B) Direct Labor, Plant Operating Labor	2.7
Supervision	0.4
(C) Maintenance Labor	4.1
Material	2.1
(D) Payroll Overhead	1.2
(E) Operating Supplies	1.3
Total Direct Cost	26.5
Indirect Cost	
General Administrative	1.1
Indirect Operating	4.2
Total Indirect Cost	5.3
Fixed Costs	
Local, County, State Taxes and Insurance	3.6
Depreciation	14.8
Total Fixed Costs	18.4
Cost of Operation Without Profit and Interest	50.2
Cost Per Gallon of Product, Cents	10.8¢

"Start-up expense" has been ignored by USBM and "working capital" appears to be much too small. "Start-up expense" is based on petroleum industry experience for employe training and recruiting, and for initial operation at less than design capacity. This item has been capitalized and depreciated over the composite life of the facilities. "Working capital" is based on the fact that considerable time will elapse before any cash return will be realized from the sale of products and that inventories of catalysts, chemicals, and other supplies are necessary. This item is not depreciated since the average daily cost of these prepaid expenses are included in the operating costs.

The USBM alleges that an allowance for start-up expense is included in their investment estimate. If this is true, the difference in the investment estimates is even greater. The NPC figure for working capital amounts to approximately 10 percent on plant investment which is to be compared with Pogue's thirty-oil-companies' working capital which in 1950 averaged 19 percent on gross property, plant, and equipment.

TABLE 4
Coal Hydrogenation Plant, Rock Springs, Wyo.
Financial Analysis and Return on Investment as Estimated by USBM

	Millions of Dollars Per Year
Total Value of Products	73.6
Cost of Operation Ex. Profit and Interest	50.2
Gross Profit	23.4
Interest on Funded Debt (3½ Percent)	8.6
	14.8
Average Interest Income	4.3
	19.1
Coal Depletion Allowance	1.5
Taxable Net Income	17.6
Income Taxes at 50 Percent	8.8
Net Income	8.8
Coal Depletion Allowance	1.5
Net Funds Available	10.3
Net Funds as Percent of Equity Capital	6.2

Table 3 shows the yearly operating expenses as reported by the USBM; these costs are expressed in terms of cost per gallon of total product. These costs will be compared with the NPC estimate later on.

Table 4 summarizes the USBM financial analysis and calculated return on investment for the Rock Springs plant. This analysis shows a return of 6.2 percent to the equity capital on the basis of 40 percent equity capital. Although we do not agree with all of the figures presented, it is interesting to note here that the return would only be about 3.5 percent on the basis of 100 percent equity capital. This last would probably be the case if one or more oil companies ventured into commercial coal hydrogenation. It is certainly a very low return.

Table 5 compares operating expenses as estimated by the NPC and the USBM for a plant at Rock Springs. The difference between the yearly operating costs, excluding depreciation, is $18.9 million. This difference is, of course, even greater with the addition of depreciation. Because of the comprehensiveness of the NPC study and the quality of the personnel used in development of these figures, it is firmly believed that the USBM's estimation of operating costs for the processing plant are decidedly low.

The NPC breakdown of costs, as reported in the subcommittee report, have been consolidated somewhat to conform to USBM's method of reporting operating costs. Actually, the NPC estimate was considerably more detailed. Only one liberty has been taken with the USBM's estimate, and that was to remove the mine depreciation at 4 percent from the mining expense. This has been added to the plant depreciation under fixed costs.

There is no explanation available for the difference between the coal mining costs and the catalyst and chemicals costs. The USBM does not detail how these costs were calculated. The cost of TEL for the USBM is logically higher since the aromatics were removed from the gasoline stream causing it to have a lower unleaded octane number.

Difference in Costs

The next item, plant direct labor, is where one of the big differences lies. The NPC estimates that 238 men per shift will be needed for direct operation of the plant. The USBM estimates that only 156 men per shift will be necessary. In R. I. 4564, the USBM estimated 243 men per shift and now with a larger plant and the addition of aromatic ex-

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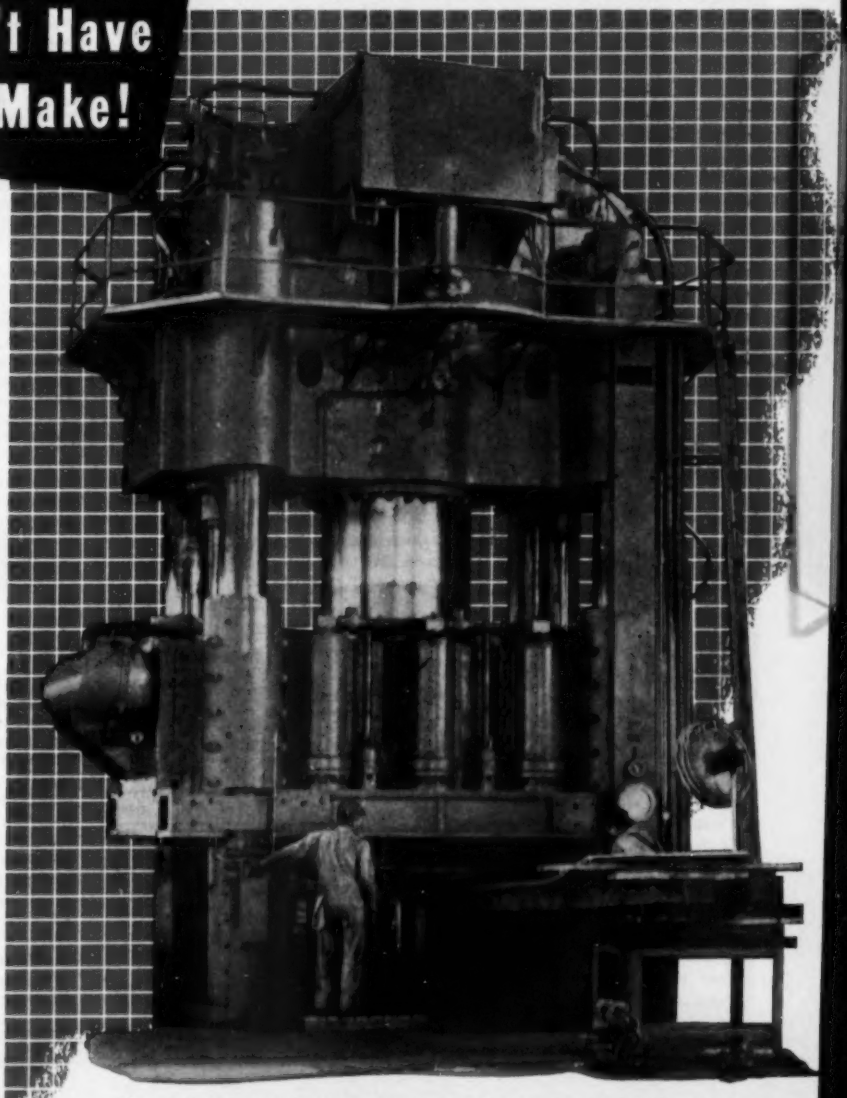

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traction, they have reduced the operating labor by 36 percent. When it is recognized that the NPC utilized personnel completely familiar with plant operation, having, in many cases, information on facilities quite similar to those under investigation, one can only arrive at the conclusion that the USBM estimate is far too low. Anyone familiar with the development of new projects and the staffing of operating facilities knows that one of the major points at which underestimation is likely to occur is on process labor. The NPC estimate of 238 men per shift, if anything, is probably on the low side.

Of even more importance is the difference which occurred in the development of maintenance cost factors. The USBM maintenance labor cost figures are based on the estimate that four maintenance workers are needed for every three operators, including supervisors. Using the same basis proposed by the Bureau, one would expect the same maintenance cost on a hand shovel as that needed on a two-ton steam shovel, since in both cases, one man is required for operation. This is an erroneous assumption, and, since the operating labor estimate is too low, the error is compounded. Maintenance material in turn was estimated by USBM to be 50 percent of maintenance. It can be seen by this that the total maintenance cost is tied to the low operating labor figure. Maintenance labor and material amount to only 1.73 percent per year on the plant investment, which is less than half the average experienced by the oil industry.

Estimate for Maintenance

The NPC's estimate for maintenance labor is 2.5 percent per year on the plant investment. Maintenance material is 1.4 percent on the same basis. This makes the total maintenance cost estimate 3.9 percent per year on the plant investment. Backing up this number are the combined efforts of many experts directly connected with this problem in the oil industry and the records of numerous refinery operating cost statements.

The two studies are more or less together as to the percentage used for such items as supervisory labor, general overhead, payroll extras, and administrative overhead, but since the USBM started out with such unrealistically low operating labor and maintenance costs, the differences mounted to $18.9 million on the final operating cost excluding depreciation.

Table 6 presents a summary of the economics as calculated by the NPC for a coal hydrogenation plant at Rock Springs. Included is a summary of economics based upon the USBM estimates

TABLE 5
Coal Hydrogenation Plant, Rock Springs, Wyo.
Comparison of Operating Costs

	NPC	USBM
Plant Size, Bbls./CD	27,000	30,000
	Millions of Dollars per Year	
Direct Cost		
Coal Mine	9.3	11.7
Catalyst and Chemicals	2.4	1.8
T.E.L.	0.1	0.8
Direct Labor, Plant		
Operating Labor	4.2	2.7
Supervision	0.6	0.4
Maintenance Labor, Plant	10.1	4.1
Material	5.4	2.1
Payroll Overhead	3.0	1.2
Operating Supplies	1.1	1.2
Total Direct Cost	36.2	26.0
Indirect Cost		
General Administrative	10.7	1.1
Indirect Operating		4.2
Research and Development	1.0	...
Total Indirect Cost	11.7	5.3
Fixed Costs		
Local, County, State Taxes and Insurance	5.9	3.6
Depreciation, Operating Facilities	20.8	15.3
Total Fixed Costs	26.7	18.9
Cost of Operation	74.6	50.2
Cost of Operation, Excl. Depreciation	53.8	34.9

and presented in the same form as the NPC economics.

In the NPC method of reporting the economics, all products other than gasoline were considered by-products. All by-product income was credited back to plant operation and the cost of the gasoline was calculated accordingly. On this basis the NPC found that the gasoline cost, including income taxes at 50 percent and a 6 percent profit on total investment, amounted to about 41 cents per gallon. This is exclusive of any marketing expense. From this estimate, it is apparent what a large part of the gasoline cost is accounted for by taxes and profit.

On the same basis the USBM estimate shows a gasoline cost of 20 cents per gallon. This is far more than the cost of gasoline from petroleum, in spite of the facts already presented showing the USBM estimates to be low. It will be noted that using USBM numbers the income tax payment is some $1.5 million less than the profit, whereas the profit and taxes are the same for the NPC economics. This lower income tax is due to the fact that USBM assumed they could establish an arms-length deal to get a coal price which resulted in a statutory depletion allowance of 30 cents per ton. However, this depletion allowance swings the gasoline cost only 0.3 to 0.4 cents per gallon. At the time the NPC calculations were made, the depletion allowance was only 5 percent instead of the current 10 percent of the gross, and only cost depletion was taken by the NPC in preference to the use of assumption employed by the USBM.

Table 6
Coal Hydrogenation Plant, Rock Springs, Wyo.
Comparison of Economics on Basis of 6% Return After Income Tax
Millions of Dollars Per Year

	NPC	USBM
Total Operating Expense	53.8	34.9
Depreciation, Plant, Housing, Etc.	24.8	15.3
Sub-Total	78.6	50.2
Credit for By-Products	—16.5	—42.3
Other Credits	— 2.4	...
Cost of Gasoline Before Profit	59.7	7.9
Return on Investment at 6 Percent Per Year	32.0	24.7
Federal Income Taxes at 50 Percent	32.0	23.2
Cost of Gasoline Including Return Per Year	123.7	55.8
Cents/Gallon	41	20

Minimum Financing Basis

Several questions have been raised concerning the use of a 6 percent return, after income taxes, on the total investment as the economics were set up by the NPC. On this basis, effective capital charges amount to 12 percent, which includes income taxes of 50 percent. It was decided to go this route since 6 percent represented a minimum financing basis and costs developed in this manner would cover any conceivable ratio of equity to borrowed capital. The variation of effective capital charges (defined as interest on borrowed capital plus income taxes) by borrowing capital and thereby reducing the equity capital is shown in Table 7.

This table probably covers the entire range of financing schemes at 6 percent return, since even utilities, a very stable and well protected industry, are seldom financed with less than 40 percent equity capital. However, this table does not mean to imply that each level of percent of equity capital, carrying a 6 percent return, is equally attractive to the equity investor. Actually, as the percent of equity capital is reduced, the equity investor requires a larger return because of the greater risk involved on his part. In such a case, if the project should fail, the assets of the company must be used to pay off the borrowed capital, the equity investor getting whatever is left. Therefore, the equity investor demands a return commensurate with the risk of losing his capital.

Perhaps a more reasonable approach to determining how the equity investor should fare is to allow the effective capital charges to remain at some level such as 12 percent and calculate the return to the equity investor at various levels of percent equity capital. Table 8 shows such an approach. Here it is shown that by holding the total effective capital charges constant and reducing the percent equity capital, the return on equity capital is increased. This does not necessarily mean that the equity investor would be equally satisfied with each scheme in this table. The purpose of the table is to show that with constant total effective capital charges, the equity investor is offered a better yield

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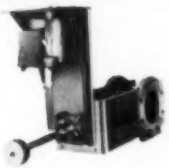

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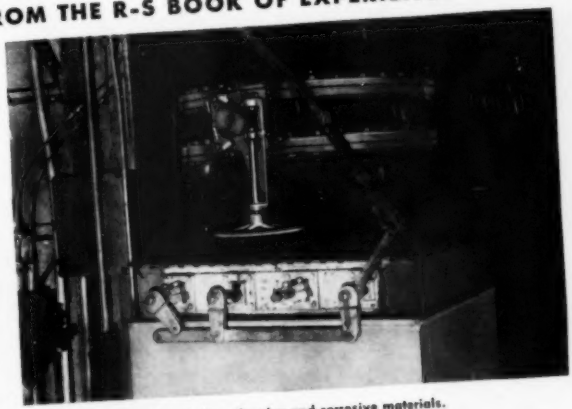

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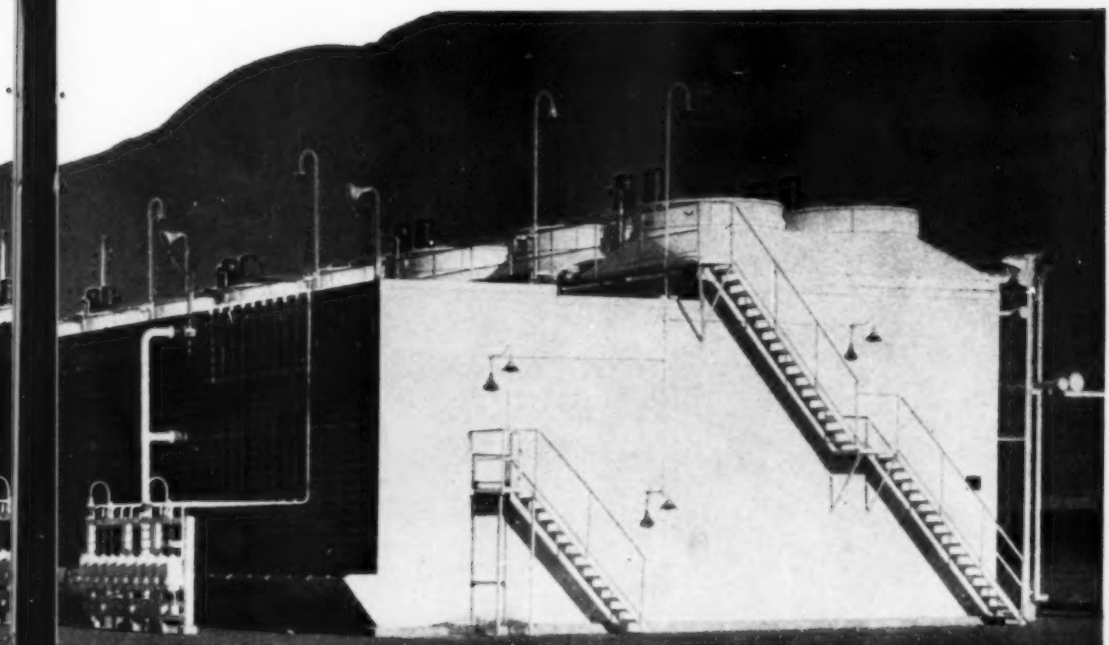
When water in good quantity and quality is not available the COMBIN-AIRE has manifest advantages over any alternative combinaton of cooling equipment.

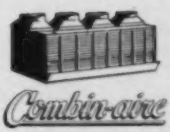
Even when ample water is available and water treatment costs are low, comprehensive comparisons will frequently indicate overall advantages of the COMBIN-AIRE system.

* The COMBIN-AIRE unit is protected by United States patents

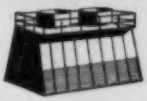


This COMBIN-AIRE unit operated by the Plymouth Oil Company in their Sweeny plant at West Texas absorbs heat from all absorption and fractionating plant streams, a total heat load of about 70 million B.T.U. per hour.

Combin-aire DOES WORK OF THREE COOLING UNITS



Combin-aire



COOLING TOWER

AIR COOLED CONDENSERS AND COOLERS

WATER COOLED CONDENSERS AND COOLERS

Combin-aire ADVANTAGES

- **LOW WATER CONSUMPTION.** No water is used during cold weather.
- **NO TREATMENT NECESSARY** for cooling tower water.
- **NO WATER LOSS** as spray or mechanical carryover.
- **NO CONDENSATION** from effluent air.
- **MINIMUM PIPING. COMBIN-AIRE** may be installed immediately adjacent to other process equipment. Use of tubular water cooled equipment for final coolers unnecessary.
- **CLEAN AIR TO AIR-COOLED UNITS.** During hot season air is water-washed removing dust, sand and insects.

In addition to COMBIN-AIRE units, HUDSON manufactures water cooling towers, air-cooled and water-cooled coolers and condensers, and is experienced in plant layout, piping, and water treatment. We shall be glad to assist pospective plant owners in making overall comparisons of first costs and operating costs for complete cooling systems using various plant layouts and combinations of equipment.

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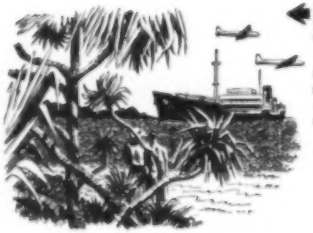
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

"What does it take from an oil company to run an airlift?"

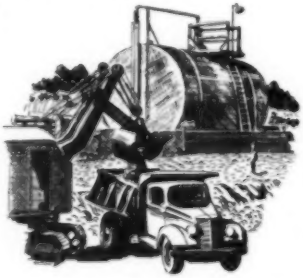
Ever since mid-summer of 1950, military activity in Korea *has called for heavy trans-pacific air traffic by civilian cargo planes. Over one of their routes they fly a round trip of 13,450 miles—some 26 times the length of the famous Berlin airlift. Hundreds of companies help supply this operation. Maybe you'd like to know what it takes from an oil company to run an airlift.*

Standard's part in the Pacific airlift shows that it's a big help to have large companies on hand when the going gets rough. Our work is focused mainly at Wake Island, that pinpoint some 4000 miles from the U. S. West Coast. After World War II, Wake was a refueling stop for commercial airliners en route to the Orient. But then came the struggle at the 38th parallel—

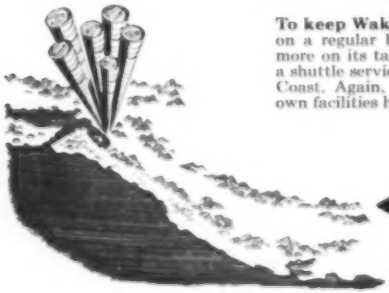


Before trouble kindled in Korea, only 20 planes a week refueled at Wake Island. Then that number multiplied many times—calling for more gas *fast*. We'd been serving the island; when the U. S. asked us to step up deliveries, we were able to do it. As a big, integrated company, we called on our own tanker fleet.

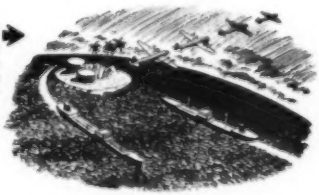
As air activity stepped up even more, Wake needed larger ground crews. Standard's bigness helped again. Using facilities in Honolulu, we quickly trained men to handle high-octane gas, tripled our manpower on Wake.



To secure the special loading equipment needed by the ground crews, a Standard ship picked up the nearest available—at far-off Canton Island. And at U. S. request, we helped build new storage facilities at Wake.



To keep Wake and the airlift supplied on a regular basis, Standard drew once more on its tanker fleet. We now operate a shuttle service to Wake from the Pacific Coast. Again, being big and having our own facilities helps us serve.



Of course, the transpacific airlift starts in America, and at home on this end of the route Standard keeps some 10 airlines supplied with aviation gasoline. It would take a stack of drums *a mile high* to hold our increased daily output for this use. At the same time, we're also supplying military needs . . . and our usual volume for motorists.

STANDARD OIL COMPANY OF CALIFORNIA

• plans ahead to serve you better

on his investment when a portion of the capital is borrowed. Compare the return on equity in this table at 40 percent equity capital with the equity investor's return as calculated by the USBM. The USBM on 40 percent equity capital showed a return of 6.2 percent. This tabulation shows that using a 6 percent return on total investment, the 40 percent equity capital yield is almost twice as much as the USBM.

It should be emphasized that this table illustrates what the NPC had in mind when they added an annual return of 6 percent on total invested capital. The effective capital charge of 12 percent, before income taxes, was intended to cover all ratios of equity to borrowed capital and not specifically the one case in which all invested capital is equity capital.

Requirement of 15 Percent

A leading auditing firm has indicated that, for a venture such as a synthetic liquid fuel project, an annual return (after income tax and depreciation) of 15 percent of total invested capital would be required to attract equity capital. This applies to all percentages of equity capital. In the table such a return on equity capital only was reached by reducing the equity financing to the extremely low level of 30 percent of total capital. This case does not meet the conditions upon which the auditing firm based their opinion. There are scarcely any manufacturing enterprises which are capitalized with less than 40 percent equity capital and the average probably lies in the 80 to 90 percent bracket. It is probable that an annual effective return of 25 to 30 percent would be required to provide interest, income taxes and return on equity capital to assure the equity investor a return commensurate with his risk.

If synthetic fuel plants are to be built by the petroleum industry without government subsidy, it is reasonable that not more than 50 percent of the capital required could be borrowed. Experience shows, however, that the collateral for this loan would not consist of the synthetic fuel plant facilities alone; the collateral would be comprised of a first lien on any or all of the companies' assets. Therefore, the synthetic fuel plant should not be considered as having been financed with 50 percent borrowed capital. Due to the use of the total assets of the company as collateral, a lesser percentage would be the true figure, and it probably would lie somewhere in the range of 10 to 20 percent.

In discussing financing of a synthetic fuel plant, mention should be made of the interest of an eastern investment group which has talked of erecting such a plant in southern Illinois. This group's interest was aroused after it was mentioned that possibly the government would subsidize such a venture by providing a market at a fixed price. Possibly at first this sounded attractive; however, it was not too long before the investors proposed that they would be interested if, in addition, the government would guarantee to be fully liable for the plant if the operation did not prove successful. Here again is shown the doubts in the feasibility of such an undertaking at this time. Yet the USBM apparently wants to take off in all directions if only the government will appropriate sufficient money.

While the USBM does not accept the NPC's estimate of synthetic fuel costs on coal hydrogenation, they say that they are in substantial agreement with the costs on fuels from oil shales. Why they should agree with one and not with the other is hardly understandable when the same basic estimating procedures were used in both studies. Many of the NPC experts worked in the preparation of both reports. Both reports used the same return of 6 percent, after income taxes, on total investment. The apparent acceptance of the shale oil economics is probably due to the fact that the shale oil costs are more nearly competitive with present petroleum refining prices for products.

As to future prospects of synthetic fuels, the NPC report gives an indication of the order in which the various sources will come into use. The NPC report indicates that from the present outlook the next source, when necessary, of petroleum products is from the shale reserves of the Western United States. It has been estimated that these reserves contain as much as 180 billion barrels of shale oil. From this shale oil would come motor fuel, diesel fuel, LPG, and residual fuel oil. The cost of gasoline from a single plant turning out 40,000 barrels per calendar day of total liquid fuels would be about 16 cents per gallon. The cost from five similar sized plants, sharing a common pipe line, would be about 15 cents per gallon. Thus it may be seen that these costs are approaching the costs of present day refiners, at least much more nearly so than the gasoline from the coal hydrogenation process. Surely, if the USBM is interested in promoting synthetic fuels, they would do well to push a source of fuels and a process that is at least somewhere nearly competitive at the present time.

The future of synthetic fuels, in the United States, from coal hydrogenation or the Fischer-Tropsch process depends upon the coal reserves available at the time these procesess become economically feasible. Over the past several decades, some rather large numbers have been used to describe the extent and the life of the coal reserves. However, within the past few years, the USGS has started a reappraisal of these reserves.

U. S. Coal Reserves

Recently, Dr. Paul Averitt of the USGS reported to the Geological Society of America that the U. S. currently has reserves of all types of coal of 1.2 trillion tons and that only 20 percent of this, or about 240 billion tons, can be regarded as actually measured or proved. This is a considerable reduction from previous USGS estimates. Dr. Averitt pointed out that the remaining 80 percent is indicated to exist by extrapolation from existing information, or inferred from the known distribution and thickness of the coal-bearing rocks.

In the case of reserves for synthetic fuels from coal, it is of prime importance that the coal be situated near an adequate water supply and existing transportation facilities. This, of course,

TABLE 7

Variation of Total Capital Charges With a Constant Equity Capital Return

	PERCENT EQUITY CAPITAL					
	100	80	60	50	40	30
"Effective" Capital Charges, Percent Per Year On Total Invested Capital						
Interest on Borrowed Capital (at 4 Percent)	....	0.8	1.6	2.0	2.4	2.8
Return on Equity Capital (at 6 Percent)	6.0	4.8	3.6	3.0	2.4	1.8
Allowance for Federal Income Taxes	6.0	4.8	3.6	3.0	2.4	1.8
Total "Effective" Capital Charges, Percent	12.0	10.4	8.8	8.0	7.2	6.4

TABLE 8

Variation of Equity Capital Return With a Constant Total Capital Charge

	PERCENT EQUITY CAPITAL					
	100	80	60	50	40	30
"Effective" Capital Charges, Percent Per Year On Total Invested Capital						
Total "Effective" Capital Charge	12.0	12.0	12.0	12.0	12.0	12.0
Interest on Borrowed Capital (at 4 Percent)	....	0.8	1.6	2.0	2.4	2.8
Net for Income Taxes and Return on Equity Capital	12.0	11.2	10.4	10.0	9.6	9.2
Income Taxes (at 50 Percent)	6.0	5.6	5.2	5.0	4.8	4.6
Net for Return on Equity Capital	6.0	5.6	5.2	5.0	4.8	4.6
Return on Equity Capital Percent per Year on Equity Capital Only	6.0	7.0	8.7	10.0	12.0	15.3

still further reduces the reserves available for such use. An estimate of so-called "measured and indicated" coal reserves, which could be mined at reasonable costs, indicates that there is only about 110 billion tons total of reserves suitable for synthetic fuel manufacture. This is equivalent, however, to more than 200 billion barrels of oil. This figure includes the bituminous, subbituminous and lignite classes of coal.

The NPC report has shown that the hydrogenation of coal is decidedly uneconomic at the present time. There is, however, a second coal process based upon the Fischer-Tropsch reaction. This process will produce gasoline, diesel fuel, heavy fuel and wax, and oxygenated chemicals. Although this process produces less synthetic fuels per ton of coal than hydrogenation, its economics appear more attractive on present knowledge. It is believed that the cost of gasoline by the Fischer-Tropsch method will fall somewhere between that of shale and coal hydrogenation. Chemical credits could be realized on the first few plants; however, before any sizeable industry would result, the production of these chemicals would be far in excess of demand and in the long range, these chemicals would have to be converted to liquid fuels.

Need for Benzene

Since it became apparent, within the past year or so, that benzene production would fall short of demand, the USBM has been trying to promote the coal hydrogenation process as a source of benzene and other aromatics. In this connection, it is interesting to compare the estimated costs of these aromatics from coal hydrogenation and from petroleum sources.

Refer to Table 6 on which the cost of gasoline was calculated using the USBM figures plus a 6 percent return. If the gasoline is credited back at 11 cents per gallon, the price the USBM used, and the costs are calculated for the amount of benzene, toluene and xylene produced, it is found that this mixture of aromatics would cost about 78 cents per gallon. On the basis of the benzene production only, the cost would be $2.42 per gallon. The cost of 78 cents per gallon is well over double the price assigned to the aromatics in the USBM study. Yet the USBM continues to try to sell their coal hydrogenation process as an excellent and economical source of aromatics. In addition, the investment cost for aromatics on a dollar-per-barrel-per-calendar-day basis would be about $42,000. It is estimated that an investment of $10,000 per barrel per calendar day would be necessary to obtain aromatics from petroleum including facilities for new crude production, transportation, refining, processing, etc.

In view of these comparisons in costs for the production of aromatics, it does not seem probable that a coal hydrogenation project can be justified as a source of aromatic hydrocarbons. This aspect should possibly be used as counter-publicity to the USBM's promotion of coal hydrogenation as a chemical producer.

The USBM, as an example of the commercial feasibility of producing chemicals via coal hydrogenation, has cited Union Carbide's $11 million venture. The company has indicated that it is an experimental project and that they fully expect that possibly the major equipment in it will be obsolete within a relatively short time. UCC has issued a statement saying the plant would produce varying quantities of aromatic hydrocarbons, phenol and homologues, aryl amines, nitrogen heterocycles, pitch coke, high melting pitch, LPG, and some other products called intermediate fractions and high boiling crudes. On a pound basis, the production of high melting pitch seems to be the main product. However, UCC is very secretive and little about the project is definitely known. Thus, the USBM hardly seems justified in making such resounding statements about this venture.

Having discussed the current status of synthetic fuel development and economics, to complete this subject it is necessary to discuss the question of the necessity of synthetics at the present time and when the need for an intensive program will arrive.

A. L. Solliday, executive vice president of Stanolind Oil and Gas Company, before your organization in San Antonio on October 6, 1949, said that after setting future demand for petroleum as high as was feasible and supply as low as could be visualized, it still appeared there would be no necessity to develop appreciable production from synthetic fuels until after 1961. He specifically excluded any war time use of petroleum in his estimate, although it was stated that war demands could be satisfied. Since that time the advent of the Korean war and the entrance of Red China into the conflict have substantially increased the demand for petroleum production. In addition, the Iranian situation forced upon us last year materially affected the demand for products and the availability of crude for import into this country. Despite this, the U. S. has met all demands, and crude production is prorated substantially in Texas.

At the time of Mr. Solliday's forecast, it was estimated that the total demand for petroleum in the United States would be about 8.4 million barrels per day by 1965. Our present estimate is about one million barrels per day higher, or 9.4 million. In spite of the vastly growing demand for petroleum products, it now appears that the need for synthetic fuels is even further away than it appeared previously. The vast efforts which have been made by the industry to find and develop more oil, and the success we have had in finding it, would make all previous estimates look entirely too conservative. The advent of Scurry County, the commercialization of Spraberry, and recent developments in North Dakota and Montana have indicated that the vast potential still exists. Recent estimates by our own company, which cover a period of 15 years into the future, do not indicate any need for synthetic fuels during that time, and this is true even if imports are maintained at today's levels and do not increase as we have every reason to believe will occur during the coming years.

Future Oil Supply

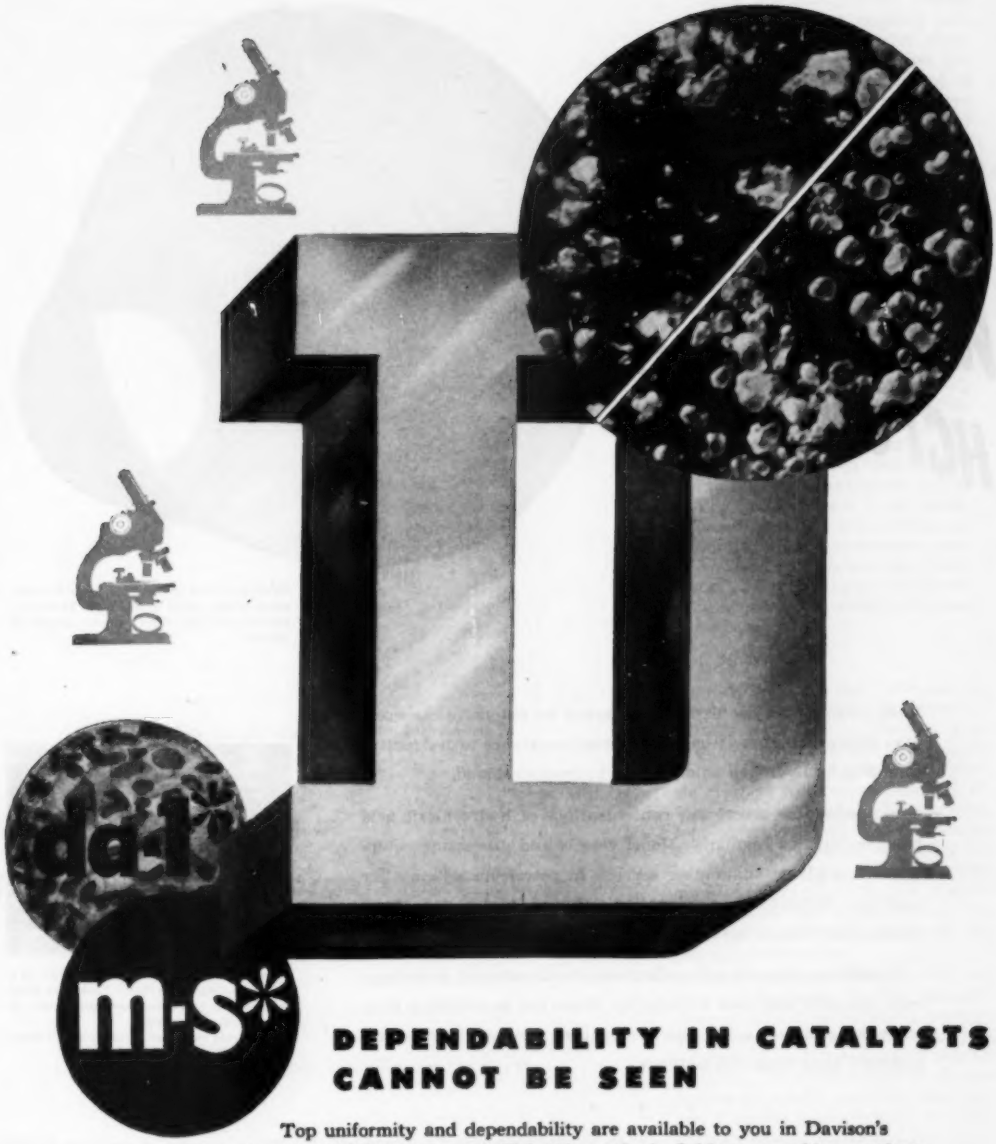
It would now appear that we can anticipate sufficient oil to insure meeting all demands during the next 15 years. In making this statement, it is assumed that recovery methods will be the same as those being practiced today. In addition, however, we feel there will be 50 to 100 billion barrels of oil recovery through new secondary recovery methods not now in use. We are firmly convinced that our forecasts of primary recovery oil are entirely conservative, but even if they do prove to be optimistic, there is no doubt that we can fill all our needs by these new methods without difficulty. This will occur at prices considerably below those indicated for liquid fuels from coal hydrogenation.

It is sincerely believed that the USBM would provide a much better service to the country and industry in continuing their research on synthetic fuels and not promoting them. In this respect, it is understood that the much publicized coal hydrogenation demonstration plant in Missouri has never run continuously. Each step has operated at one time or another but never as a continuous unit. There is a great difference in operating in a batchwise fashion as compared with a continuous operation. It would be well if they would stress and improve their fundamental research work and let industry take care of the building of commercial plants.

When the time comes for commercial production of synthetic fuels, the petroleum industry will be ready. Until that time, it would be a great waste of money and manpower to move into a field that is so decidedly uneconomic. The development of synthetic liquid fuel manufacture should follow a normal course under straight forward economics.

ACKNOWLEDGMENT

Original presentation of this discussion was before the Mid-Continent Section, American Institute of Mining and Metallurgical Engineers, at Tulsa in January.



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Top uniformity and dependability are available to you in Davison's microspheroidal (M-S*) or ground (DA-1*) synthetic fluid-type cracking catalysts. The accompanying photomicrographs show the physical characteristics of the DA-1 and new M-S catalysts produced in Davison's Cincinnati plant. Uniform physical and catalytic characteristics result from Davison's modern facilities and years of technical experience and research. Experienced Davison Field Service Engineers—complete laboratory facilities—are all part of Davison Dependability—Dependability with the big "D".

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Monel-lined top section of a large fractionating column. Made by the A. O. Smith Corporation for one of the nation's largest oil refiners.

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In applications where low concentrations of hydrochloric acid must be handled regularly, Monel vessels and processing equipment have given outstanding service. In petroleum refining, for example, Monel-lined fractionating columns, tanks, and Monel piping and fittings have substantially outlasted other metals.

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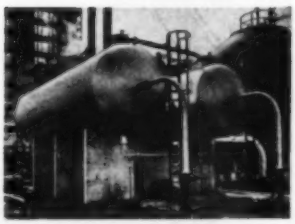

Monel-lined tanks installed at the plant of a large Southern oil refiner. Tanks are lined with Monel to combat corrosive action of dilute hydrochloric acid.

The tanks were fabricated by Wyatt Metal & Boiler Works, Houston, Texas.

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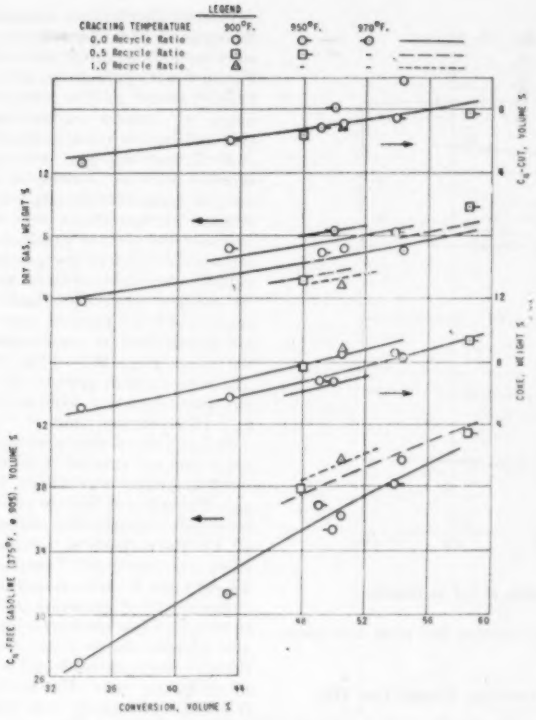

Figure 1. Product Distribution as a function of Conversion.

Catalytic Cracking of High Nitrogen Charge Stock

Part I. Presentation of Experimental Data

J. W. SCHALL and J. C. DART

Houdry Process Corporation, Marcus Hook, Pa.

THIS PRESENTATION shows the results of a moving bed catalytic cracking pilot plant investigation to determine the cracking characteristics of a high nitrogen content charge stock. The charge stock used was a 21.2° API gravity, 910° F. E.P. gas oil containing 0.4 weight percent nitrogen. Also included are the results of a single run made to determine the cracking characteristics of a first pass catalytic gas oil obtained from moving bed cracking the virgin heavy gas oil.

This first article presents the effects of the process variables, particularly cracking temperature, recycle ratio, and catalyst to oil ratio, on product distribution and product quality when cracking a high nitrogen charge stock. Part II, to appear in an early issue, will give a series of combination charts which can be used to estimate the product distributions obtained when cracking a high nitrogen charge.*

THE effect of process variables on product distribution and product quality when cracking stocks which are essentially free of nitrogen has been previously investigated and reported.[1,2] In the previous investigation correlations were derived which showed the interrelationship of the yields of the various products from the cracking reaction and the effect of the process variables on these yields. The correlations have been found applicable to all stocks which are essentially nitrogen-free.

Scattered data available on the once-through cracking of high nitrogen content charge stocks indicated that their basic cracking characteristics were different from those of low nitrogen content charge stocks. No information was available on the recycle cracking of virgin high nitrogen content charge stocks. The aforementioned correlations based on cracking a nitrogen-free stock would therefore be of limited use to the refiner or process engineer when processing high nitrogen content stocks. The investigation reported herein was undertaken to provide a means of estimating the product distributions obtained when cracking a high nitrogen content charge stock and to determine the effect of the process variables on the product distributions.

The subject is presented in two sections: 1) Experimental data presented show product distribution, product quality and nitrogen distribution as a function of conversion and/or process variables. 2) A discussion of the experimental results including the general cracking characteristics of high nitrogen content stocks and the application of these data to other high nitrogen content stocks.

Experimental Data

The experimental results reported herein were obtained by both once-through and recycle cracking a high nitrogen content gas oil over plant-aged clay catalyst in moving bed pilot units. The pilot units have a maximum charge capacity of three barrels per day. In recycle operation, continuous

*This paper was originally presented before The Third World Petroleum Congress, The Hague, May 28-June 6, 1951.

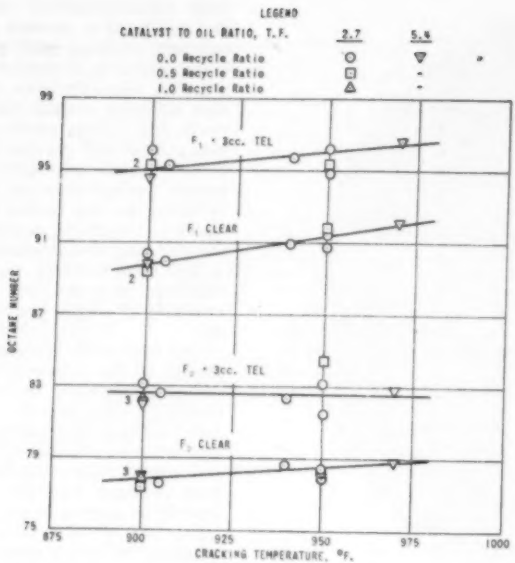

Figure 2. Effect of Temperature on Octane Rating of C_4-Free Gasoline.

fractionating towers were used to prepare the cycle oil stream. Inspections of the heavy gas oil used in this investigation are summarized in Table 1.

A plant-aged clay catalyst of essentially 30 Activity Index was used throughout this study.

The experimental program consisted of a series of 10 runs, 7 once-through and 3 recycle, made at cracking temperatures of 900° F., 950° F., and 970° F. Table 2 shows the number of runs made at each cracking temperature and recycle ratio.

A once-through run at both 900° and 970° F. was made using a catalyst to oil weight ratio of 5.4. A catalyst to oil weight ratio of approximately 2.7 was used for all other runs. The extent of cracking was varied by changing space rate over the range of 1.1 to 7.8 (wt./hr./wt.). Nitrogen balances were obtained on the majority of runs.

One run was made in a six liter fixed bed pilot unit to obtain an indication of the cracking characteristics of the first pass catalytic gas oil. The total gas oil obtained from the once-through, low conversion run made in the moving bed unit at 900° F. was fractionated to remove five volume percent bottoms based on the virgin gas oil. This bottoms-free catalytic gas oil was cracked over clay catalyst at 900° F. in the fixed bed pilot unit. The fixed bed unit was operated isothermally to simulate, as closely as possible, moving bed pilot unit operation.

Cracking Virgin Gas Oil

Product Distribution

Conversion is used to designate the extent of the cracking reaction and is defined herein as 100 minus the percent catalytic gas oil based on fresh feed charge. In recycle operation, catalytic gas oil includes the light gas oil and polymer bottoms. The weight percent conversion may also be defined as the sum of the weight percent yields of gasoline and lighter products plus coke.

TABLE 1

HEAVY GAS OIL	
Gravity, °API	21.2
Distillation, °F.	V.A.
I.B.P.	615
10 Percent	735
50 Percent	825
90 Percent	.....
Maximum Temperature	910
Recovery, Percent	85.0
Aniline Point, °F.	175
Nitrogen, Weight Percent	0.40
Sulfur, Weight Percent	1.13

TABLE 2

	Number of Runs		
Cracking Temperature, F.	900	950	970
Recycle Ratio:			
0.0	3	3	1
0.5	1	1	..
1.0	1	..	..

Product distributions obtained from the series of 10 runs are shown graphically as a function of conversion in Figure 1 with parameters of cracking temperature and/or recycle ratio noted. At constant cracking temperature and recycle ratio, yields of gasoline, C_4 cut, dry gas, and coke all increase with an increase in conversion. At constant temperature and conversion, an increase in recycle ratio increases the yield of gasoline and decreases the yield of dry gas but does not affect the yields of C_4 cut and coke. At constant conversion and recycle ratio, yields of gasoline and C_4 cut are independent of temperature over the range from 900° F. to 970° F. The coke yield decreases and the dry gas yield increases with an increase in cracking temperature.

It has been shown previously that space rate and catalyst to oil ratio are interchangeable variables in both once-through and recycle cracking of essentially nitrogen-free charge stocks (2, 1). The majority of the runs in this study were made at 2.7 catalyst to oil weight ratio. In order to test the interchangeability of space rate and catalyst to oil ratio when cracking a high nitrogen content charge stock, two once-through runs were made at 5.4 catalyst to oil weight ratio. The product distributions obtained from these two runs are shown in Figure 1 at 54.4 percent conversion and 900° F. and at 50.0 percent conversion and 970° F. These data show that no significant differences in product distribution are obtained at constant conversion and cracking temperature when the catalyst to oil ratio is increased from 2.7 to 5.4 with appropriate changes in space rate. Therefore, space rate and catalyst to oil ratio are interchangeable variables in the cracking of high nitrogen content charge stocks over the range of catalyst to oil ratios investigated.

Product Quality

The octane rating of the C_4-free gasolines obtained from the pilot plant has been determined and is presented graphically. The effects of process variables and/or conversion on the nitrogen distribution in the products are also shown graphically.

Octane ratings of the C_4-free gasolines (375° F. at 90 percent evaporated) are shown in Figure 2 as a function of cracking temperature. The unleaded F-2 (motor method) and the leaded and unleaded F-1 (research method) octane ratings increase 1-2 numbers with an increase in cracking temperature from 900° to 970° F. The leaded F-2 rating remains constant. Since the single lines shown in Figure 2 adequately define the experi-

mental data, no effect of either conversion or recycle ratio on octane ratings is indicated. The above effects, in general, are in accord with those observed previously for catalytic motor gasolines.

The heavy gas oil used in this investigation has a nitrogen content of 0.40 weight percent. Steam condensate, coked catalyst, and gas oil streams obtained during this program were analyzed for nitrogen content. Two gasoline samples obtained at 900° and 970° F. and several unit gas samples obtained at 900° F. were also analyzed for nitrogen. It should be emphasized that a high degree of accuracy in the nitrogen determinations on the various samples is lacking. Pilot plant nitrogen balances are reported herein on an actual recovery basis with no corrections being made to obtain a 100 percent balance.

Nitrogen analyses on the two gasolines obtained at 900° and 970° F. indicate that approximately 4 weight percent of the nitrogen originally in the charge stock appears in the gasoline in both cases. Based on these two analyses, it is assumed that the percentage of charge nitrogen in the gasoline remains constant at 4 weight percent over the range of catalyst to oil ratio, temperature, and conversion covered in this investigation. Merely a trace of nitrogen was found in the unit gas obtained when cracking at 900° F.

The percentage of charge nitrogen appearing in the steam condensate, coked catalyst, and gas oil is shown in Figure 3 as a function of catalyst to oil weight ratio based on fresh feed. Parameters of cracking temperature are indicated where applicable. No significant effect of conversion or recycle ratio on nitrogen distribution is indicated. Nitrogen distributions are summarized in Table 3.

The nitrogen balances obtained are reasonably good and several general trends can be noted. The percentage of charge nitrogen appearing in the steam condensate and in the gas oil decreases with an increase in catalyst to oil ratio (fresh feed basis) but is not affected by cracking temperature. The percentage of charge nitrogen in the coked catalyst increases with an increase in catalyst to oil ratio at constant temperature and decreases with an increase in temperature at constant catalyst to oil ratio.

More of the nitrogen compounds originally deposited on the catalyst may thermally decompose with an increase in cracking temperature since, at constant catalyst to oil ratio, the percentage of charge nitrogen on the coked catalyst decreases with an increase in temperature. Thus, it may be reasonable to assume that the nitrogen content of the unit gas will increase with an increase in temperature from 900° to 970° F. If such is the case, better nitrogen balances would be obtained at the 950° and 970° F. cracking temperatures.

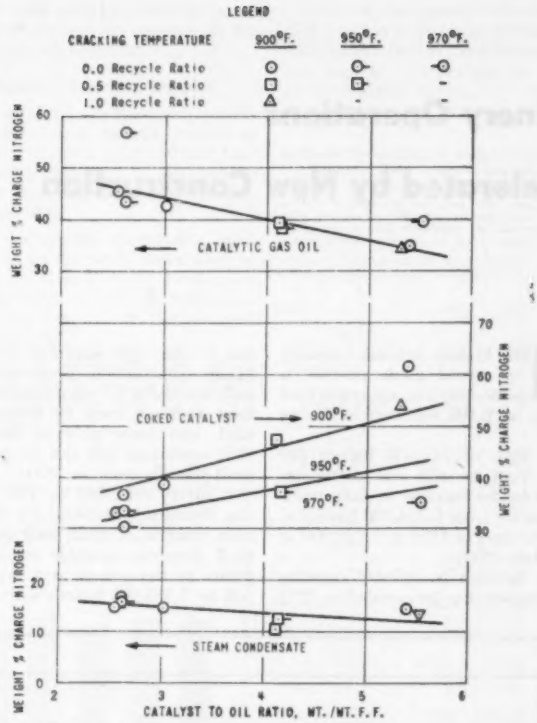

Figure 3. Weight Percent Charge Nitrogen in Reactor Effluent as a Function of Catalyst to Oil Ratio.

TABLE 3

Cracking Temp., °F.	900		950		970
Cat. to Oil Ratio, Wt./Wt., F.F.	2.5	5.0	2.5	5.0	5.0
Product Streams, Wt. % Chg. Nitrogen:					
Steam Condensate	15	12	15	12	12
Coked Catalyst	38	53	32	43	38
Gas Oil	46	34	46	34	34
Gasoline	4	4	4	4	4
Unit Gas	nil		undetermined		
Total Recovery	103	103	97	93	88
Gain or Loss (Includes inaccuracies and/or Nitrogen in unit gas)	+3	+3	−3	−7	−12

TABLE 4

Conversion, Volume Percent	26.6
C_5-Free Gasoline (375° F. at 90%), Vol. Percent	26.6
Gas Oil, Volume Percent	63.4
C_4 Cut, Volume Percent	6.2
Dry Gas (C_2 & Lighter Product), Weight Percent	4.6
Coke, Weight Percent	4.6
Gasoline Octane Ratings:	
F-2 Clear	79.3
F-2 + 3 cc TEL	84.7
F-1 Clear	92.4
F-1 + 3 cc TEL	97.8

Cracking Catalytic Gas Oil

In order to obtain an indication of its cracking characteristics, a catalytic gas oil charge stock was prepared from the total gas oil obtained from cracking the virgin heavy gas oil in the moving bed unit at 900° F. and 33.9 volume percent conversion. The total gas oil was fractionated to remove a bottoms cut equivalent to 5 volume percent of the virgin gas oil charge. The bottoms-free catalytic gas oil was then cracked over clay catalyst at 900° F. in the six liter fixed bed pilot unit. This unit was operated isothermally to simulate moving bed pilot unit operation.

A brief summary of the product distribution and gasoline octane ratings obtained from this run is presented in Table 4.

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[1] Maerker, J. B., and Schall, J. W., Houdry Pioneer, Vol. V (1950), No. I, August.
[2] Schall, J. W., Dart, J. C., and Kirkbride, C. G., Chemical Engineering Progress, Vol. XLV (1949), No. 12, 746.

End of Part I. Part II will appear in an early issue.

Refinery Operations Accelerated by New Construction

LAST YEAR the U. S. refining industry reported the highest refinery capacity on record, a fact which contributed greatly to peak daily average crude runs to stills of over six million barrels. Tight materials supply is expected to prevent duplication of this record capacity growth in 1952, and indications are that refineries will have to run at 93.5 percent capacity to meet demands by the third quarter of this year.

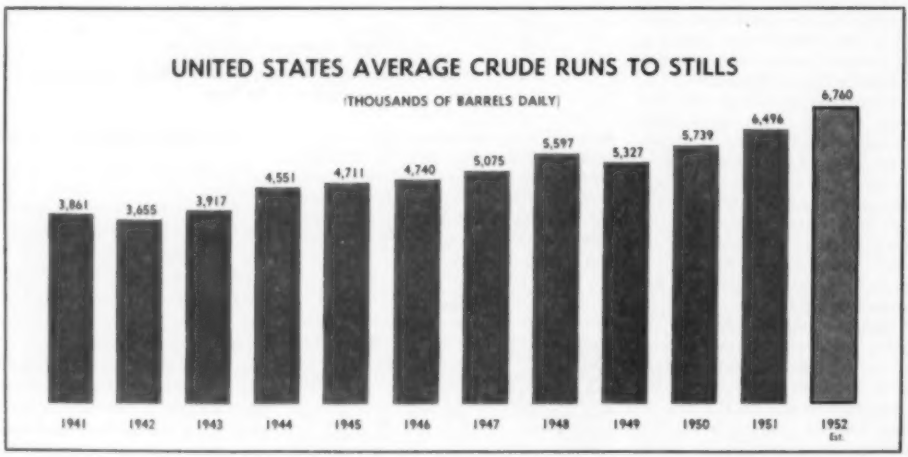
THE highest refinery capacity on record made possible a peak daily average crude runs to stills of 6,496,300 barrels during 1951.

This hike of 757,000 barrels per day in runs to stills was partly explained by the increase in daily refinery capacity from 6,724,000 barrels in the latter part of 1950 to 7,229,000 in December, 1951.

This increase in refinery capacity is not expected to be equaled in 1952 due to the tight materials situation. Many construction programs originally scheduled for completion in 1951 have been set back by shortages of steel, and some projects slated for 1952 operation will not be available until possibly early in 1953.

A survey compiled by The American Petroleum Institute for the first nine months of 1952 indicated that total domestic operable refining capacity by the end of next September will be 7,365,600 barrels daily, which would be an increase of 136,600 barrels over the figure for December, 1951.

While the additions to capacity in 1951 were ahead of the Petroleum Administration for Defense's over-all refinery program of new capacity, which was for 1 million barrels a day to be on stream in 1953, the present indicated construction program for the first three quarters of 1952 will set this program back considerably. PAD's first plan had been to make



(All Figures in Barrels)

YEAR	Annual Total	Daily Average	YEAR	Annual Total	Daily Average	YEAR	Annual Total	Daily Average	YEAR	Annual Total	Daily Average
1918	326,025,000	893,200	1927	828,835,000	2,270,800	1936	1,068,570,000	2,919,000	1945	1,719,534,000	4,711,000
1919	361,520,000	990,500	1928	913,295,000	2,295,300	1937	1,193,440,000	3,242,000	1946	1,730,197,000	4,740,000
1920	433,915,000	1,185,000	1929	987,708,000	2,706,100	1938	1,165,015,000	3,191,800	1947	1,852,246,000	5,074,600
1921	443,363,000	1,214,700	1930	927,447,000	2,541,000	1939	1,237,840,000	3,391,000	1948	2,048,349,000	5,596,600
1922	500,706,000	1,371,800	1931	894,608,000	2,451,000	1940	1,294,283,000	3,536,300	1949	1,944,221,000	5,326,600
1923	581,238,000	1,592,400	1932	819,997,000	2,240,400	1941	1,409,192,000	3,860,800	1950	2,094,867,000	5,739,400
1924	643,719,000	1,758,800	1933	851,254,000	2,359,600	1942	1,334,103,000	3,655,000	1951	2,371,168,000	6,496,300
1925	720,920,000	2,027,200	1934	895,636,000	2,453,800	1943	1,429,738,000	3,917,000			
1926	779,264,000	2,135,000	1935	955,790,000	2,946,000	1944	1,665,684,000	4,551,000	1952 Est.	2,474,180,000	6,760,000

Source: U. S. Bureau of Mines, except 1951, which has been calculated from Bureau of Mines for first 10 months and American Petroleum Institute weekly reports for last two months.

annual additions to capacity at the rate of 500,000 barrels daily in 1951 and 1952. This was revised downward to new-capacity additions of 350,000 barrels per day over a three-year period.

If the actual total operable refining capacity on stream at the end of September is no more than anticipated by the API, it would indicate that, based on the Bureau of Mines estimate of required crude runs to stills in the third quarter of the year averaging 6,800,000 barrels daily, refinery operations in the July-September period will have to be scheduled at 93.5 percent of capacity to meet demand. Correspondingly, operations in the first and second quarters of this year will have to average 91.8 percent of capacity. This would compare with runs to stills averaging slightly in excess of 90 percent of capacity in the last six months of 1951.

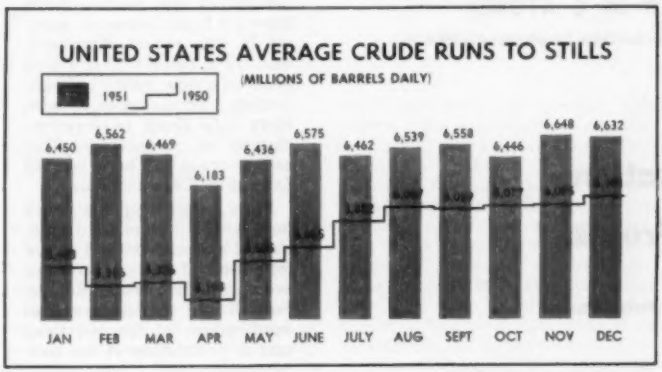
Refinery Gasoline Output

Output of refinery gasoline (straight run, cracked and natural blended at refineries) totaled 1,009,393,000 barrels during 1951 or 2,765,000 barrels per day. This was a gain of 11.2 percent over 1950.

For the second consecutive year there was an unusually sharp gain in yield of distillate fuel oils. Production reached a high of 477,149,000 barrels during the year for a 19.6 percent gain over 1950.

Lubricants production also set a new high with a total of 62,178,000 barrels during the year for a 20.2 percent gain.

Residual fuels production showed a 10.3 percent increase in moving up to 469,188,000 barrels; and kerosine output was up 14.0 percent for a total of 135,056,000 barrels.



Refinery Production of Major Products and Percent Yield from Crude Run at U. S. Refineries

Results in December and Year 1951, compared with same periods in 1950. Figures are from Bureau of Mines except that November and December, 1951, are estimated with aid of A.P.I. weekly bulletins.

(THOUSANDS OF BARRELS)

ITEM	1950	1951	Percent Dif.
Gasoline			
Production, December	80,319	89,387	11.1
(Daily Average)	2,591	2,883	11.1
Percent Yield	41.1	43.3	....
Production, Year	903,707	1,009,393	11.2
(Daily Average)	2,476	2,765	11.2
Percent Yield	43.0	42.4	....
Kerosine			
Production, December	11,261	11,608	10.3
(Daily Average)	363	374	10.3
Percent Yield	5.8	5.6	....
Production Year	118,512	135,056	14.0
(Daily Average)	325	370	14.0
Percent Yield	5.6	5.7	....
Distillate			
Production, December	41,628	45,515	10.9
(Daily Average)	1,343	1,468	10.9
Percent Yield	21.3	22.0	....
Production, Year	398,912	477,149	19.6
(Daily Average)	1,093	1,307	19.6
Percent Yield	19.0	20.0	....
Residual			
Production, December	40,475	40,197	9.9
(Daily Average)	1,306	1,297	9.9
Percent Yield	20.7	19.5	....
Production, Year	425,217	469,188	10.3
(Daily Average)	1,165	1,285	10.3
Percent Yield	20.2	19.7	....
Lubricants			
Production, December	5,068	5,578	11.0
(Daily Average)	164	180	11.0
Percent Yield	2.6	2.7	....
Production, Year	51,735	62,178	20.2
(Daily Average)	142	170	20.2
Percent Yield	2.5	2.6	....

Crude Runs to Stills in U. S. Refineries and Percent Refinery Capacity Used by Districts, December and Years, 1950 and 1951

Runs from Bureau of Mines, except November and December, 1951, from American Petroleum Institute: Capacities from American Petroleum Institute.

(THOUSANDS OF BARRELS)

Refining District	CRUDE RUN IN DECEMBER: Total Amount Run During Month			CRUDE RUN IN DECEMBER: Daily Average Run During Month		REFINING CAPACITY AND USE IN DECEMBER: Daily Capacity		REFINING CAPACITY AND USE IN DECEMBER: Percent Capacity Used		CRUDE RUN DURING YEAR: Total Amount Run During Year		CRUDE RUN DURING YEAR: Daily Average Run During Year		
	Dec., 1950	Dec., 1951	% Diff. '50-'51	Dec., 1950	Dec., 1951	Dec., 1950	Dec., 1951	Dec., 1950	Dec., 1951	1950	1951	1950	1951	% Diff. '50-'51
East Coast	29,490	32,438	+10.0	951	1,046	1,013	1,094	93.9	95.6	331,368	370,108	908	1,014	+11.7
Appalachian	4,952	5,723	+15.6	160	185	191	194	83.8	95.4	60,382	65,366	165	179	+ 8.5
District No. 1	2,932	3,180	+ 8.5	95	103	117	116	81.2	88.8	35,115	37,608	96	103	+ 7.3
District No. 2	2,020	2,543	+25.9	65	82	74	78	87.8	105.1	25,267	27,758	69	76	+10.1
Ill., Ind., Ky.	34,200	38,621	+12.9	1,103	1,246	1,178	1,317	93.6	94.6	379,143	438,106	1,039	1,200	+15.5
Okla., Kans., Mo.	15,928	16,848	+ 5.8	514	543	557	615	92.3	88.3	177,285	190,347	486	521	+ 7.2
Texas Inland	6,641	7,560	+13.8	214	244	279	290	76.7	84.1	76,221	89,662	209	246	+17.7
Texas Gulf Coast	46,695	49,944	+ 7.0	1,506	1,611	1,592	1,667	94.3	96.6	479,085	571,794	1,312	1,567	+19.4
Louisiana Gulf Coast	15,457	15,833	+ 2.4	499	511	474	507	105.3	100.8	171,407	183,359	470	502	+ 6.8
Ark., and La. Inland	2,136	2,272	+ 6.4	69	73	86	88	80.2	83.0	26,107	28,953	71	79	+11.3
Rocky Mountains	7,051	7,328	+ 3.9	228	236	249	272	91.6	86.8	72,539	83,934	199	230	+15.6
District No. 3	452	481	+ 6.4	15	15	17	22	88.2	68.2	4,963	5,381	14	15	+ 7.1
District No. 4	6,599	6,847	+ 3.8	213	221	232	250	91.8	88.4	67,576	78,553	185	215	+16.2
California	27,898	29,036	+ 4.1	900	937	1,105	1,185	81.4	79.1	321,330	349,539	880	958	+ 8.9
Total U. S.	190,448	205,603	+ 8.0	6,144	6,632	6,724	7,229	91.4	91.7	2,094,867	2,371,168	5,739	6,496	+13.2

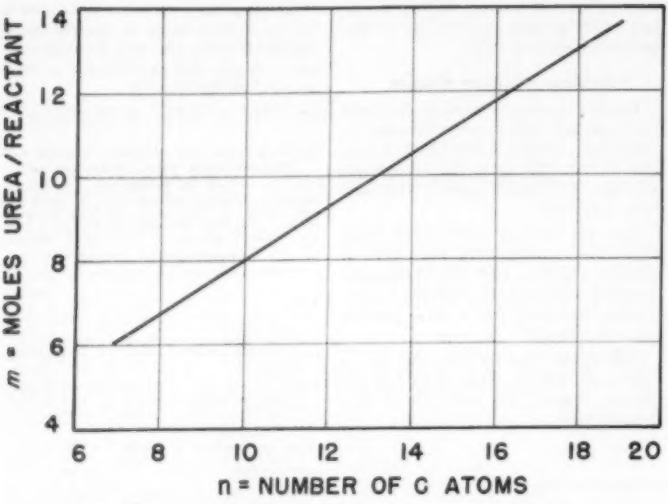


Figure 1. Dependence of Molal Ratio *m* on Chain Length of *n*-Paraffins.

AN ACCIDENTAL discovery by an alert scientist has led to the development of a new separation process which shows promise of providing the petroleum and petrochemical industries with an entirely new tool. Urea selectively forms crystalline adducts with straight-chain types of compounds while thiourea selectively forms similar complexes with many branched-chain and certain ring-type compounds. Once the crystalline complex is formed, it is removed from the reaction mixture, and the crystals are dissolved in water, destroying the complex; the reactant is then recovered as an immiscible organic layer.

Numerous industrial organizations in this country have shown a high degree of interest in this recent discovery, and as a result, there has evolved a new method of separating various types of mixtures into their respective classes of compounds. This new process has been termed Extractive Crystallization.

Parts I and II of this series deal with a theoretical discussion of material related to the formation of the crystalline urea and thiourea adducts. Part III will include practical applications of the reactions and a description of the new process.

Extractive Crystallization— A New Separation Process

PART I. Theoretical Basis

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IN THE course of the past decade, it has been discovered that urea forms crystalline addition complexes or "adducts" with long, straight-chain organic compounds, whereas thiourea forms crystalline adducts with branched-chain and certain ring-type compounds. A high degree of specificity is exhibited by these two chemicals in the formation of complexes, and the reactions involved are generally rapid and simple to conduct. Thus, if a mixture containing a long normal paraffin, such as cetane (*n*-hexadecane), and a highly branched compound, such as isooctane (2,2,4-trimethylpentane), is agitated with a saturated methanol or aqueous solution of urea, a crystalline complex forms almost immediately between the urea and the normal paraffin, leaving the branched compound in the liquid phase. The adducts can be filtered and physically handled like most ordinary crystals. They are easily dissociated upon heating or upon being dissolved in water or some other solvent. Since the two types of adducts are complementary and are generally distinctly selective in their action, there is provided a means for a separation process. Such a process has been termed "Extractive Crystallization" by Bailey et al.[4] of Shell Oil Company.

Our present knowledge of the urea adducts can be attributed to an accidental discovery by Bengen,[3a, 5a] a German, while conducting random tests with urea and pasteurized milk. Bengen had found that under certain conditions the fat separated out in such a form as possibly to justify the use of urea in a method for determining the fat content in milk. He was bothered with what was thought to be an emulsion, so he added a trace of *n*-octyl alcohol to prevent the formation of the emulsion. He chanced to set aside his sample, and later when he examined it he observed some crystals at the interface of the liquid layers. In attempting to reproduce these unexpected crystals, he found that they were formed when an aqueous urea solution was shaken with *n*-octanol. From here, it was just another step to extend the adduct formation to include higher alcohols, acids and finally paraffins and other straight chain compounds.

The first material concerning this discovery was a German patent application by Bengen[5] in 1940. However, this information was kept secret by Germany and was not publicly available until after the war when it appeared on a microfilm prepared by the Technical Oil Mission, which made the information available to industry.

Fetterly[4, 25, 26, 27] tested and greatly extended the results concerning urea adducts first reported by Bengen in his patent application. In the course of these tests, while attempting to increase the reactivity for short-chained hydrocarbons by using a different complexing agent, Fetterly[11] discovered that thiourea in a saturated solution formed a stable complex with isooctane in a hydrocarbon mixture. Further experiments showed that other neo hydrocarbons, cyclohexane and similar structures, and various halogen-carbon substances react similarly with thiourea but not with urea. The results of this work are further set forth in a patent[10] dealing with thiourea adducts. Zimmerschied et al.[37, 38] also tested and extended the work of Bengen. In France, Angla,[1, 2, 3] apparently working independently, reported results of work done with thiourea and various organic compounds. Schlenk[21, 21a, 22, 24] has reported details of work conducted in Germany in connection with urea adducts, and thiourea adducts. Thus, interest in this recent discovery has spread rapidly, and work is now simultaneously being conducted by numerous industrial organizations in the United States and also in foreign countries.

Molecular Complexes

It is stressed by Bengen and Schlenk[6] that in the urea adducts a new type of addition complex is encountered. The partners are not united in whole numbered ratios, as would be indicated by the classical coordination theory, but the adducts are built up according to an entirely different principle. Crystalline complexes other than those of urea and thiourea have been reported in the literature, and some of these are probably related to the adducts of urea and its analogs. In several cases, the concepts of structure are remarkably analogous to that of the urea adducts. In order that the structure of urea and thiourea adducts may be more clearly understood, it may be well first to consider briefly two other types of molecular complexes.

Choleic Acids

Cholic acid, $C_{24}H_{40}O_5$, a bile acid, was discovered by Strecker in 1848. Later, two more acids were isolated from bile; these were first termed choleic acid and desoxycholic acid, both with the formula $C_{24}H_{40}O_4$. Wieland and Sorge,[36] while conducting experiments with what was then recognized as choleic acid, attempted to study the effect of high vacuum distillation on choleic acid in the same manner as had proved successful with cholic acid. During this operation, they observed the appearance of palmitic, stearic and oleic acids in the overhead fraction to an extent of about eight percent of the choleic acid used. Upon further investigation, they realized that in choleic acid they were actually dealing with a complex, or coordination compound, consisting of eight molecules of desoxycholic acid plus one of fatty acid. The choleic acid had a higher melting point than either of its constituents, and it was found that the complex choleic acid could be resynthesized from fatty acid and desoxycholic acid.

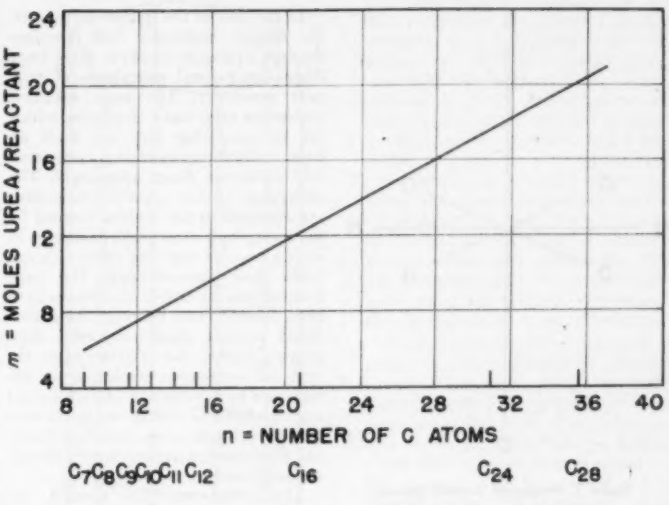

Figure 2. Dependence of Molal Ratio *m* on Ideal Chain Length of *n*-Paraffins.

Further experiments showed that other fatty acids such as butyric acid, also aromatics like phenol and naphthalene, formed complexes with desoxycholic acid. The term "choleic acid" has now been broadened to refer to all such complexes of desoxycholic acid.

Sobotka[28] pointed out that the number of desoxycholic acid molecules combining with monocarboxylic acids of the aliphatic series must conform to the general building principle of inorganic coordination compounds. These numbers must allow for a symmetrical arrangement around the pivotal atom, ion or group. He indicated that the numbers commonly encountered are four, six, eight and occasionally two and three; the numbers five and seven would not permit symmetry. Potentially higher numbers could exist but had not been verified.

In 1934, Go and Kratky[13] reported on X-ray studies of these crystalline complexes. The basic lattices of all of the choleic acids, composed of desoxycholic acid and members of the homologous series of aliphatic monobasic fatty acids, were established as the same. However, the ratio of the weight of the desoxycholic acid in the elementary cell to the weight of fatty acid was not always an integer. To explain this discrepancy, the postulation was made that the fatty acid molecules are arranged one behind the other in canals which extend through the basic lattice. The walls of the canals consist of molecules of desoxycholic acid, and the fatty acid molecules lie in the canals, oriented in a head to tail fashion. The periodically repeating order of desoxycholic acid molecules along the canal produces a corresponding periodically changing "field of intensity" in the canal, and consequently there result repeating points of high field intensity at fixed intervals along the canal. Go and Kratky point out that the fatty acid molecules do not touch each other as they lie one behind the other in the canal. Inasmuch as these enclosed molecules must take up symmetrical positions in the canal, relative to the points of high field intensity, "empty spaces" or unoccupied intervals will result between successive molecules in the canal. This arrangement leads to whole numbered molecular ratios, resulting in agreement between analytical results and X-ray findings.

Thus, in summary, for the choleic acid complexes, the physical concept has been proposed and supported by X-ray evidence, wherein reactant molecules lie in canals formed by the com-

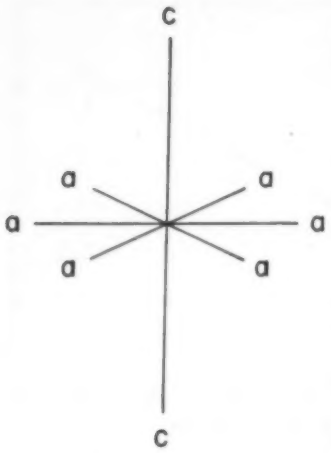

Figure 3. Hexagonal Crystal System.

plexing agent, desoxycholic acid. Furthermore, the spacing between the reactant molecules in the canals is dependent upon the field intensity imposed by the canal-forming molecules, or in effect, it is a function of the interaction between a group or radical of the reactant molecule and the complexing agent in such manner that the ratios of molecules of desoxycholic acid to fatty acid result in whole numbers.

Clathrate Compounds

The structure of another series of complexes has been studied by Palin and Powell,[15,16,17] and properties and methods of preparation of some of the specific complexes have been reported by Powell and other coworkers.[18,20,21,22,23,24] An example of this class is the group of crystalline complexes formed between quinol and any of a large number of volatile compounds, such as sulfur dioxide, hydrogen sulfide, hydrogen chloride, formic acid, methanol and acetonitrile. Powell[19] reports that some influence so conditions the geometry of one species of molecules that enclosed spaces result in which molecules of a second species are entrapped. The complexes may be visualized as consisting of a cage in which another molecule is entrapped. The cage is built up bit by bit from small components capable of separate existence in a solution which also contains a large concentration of molecules to be enclosed. Because of the cage-like structure of these complexes, Powell has applied to them the name "Clathrate" (from "clathratus"—enclosed or protected by cross bars of a grating).

In the case of the quinol complexes, the quinol molecules link together through hydrogen bonds to form huge three dimensional complexes of trigonal symmetry. The huge resultant molecules then have structures which are so open that they are built up completely interpenetrating each other but having no direct attachment. The molecules of the volatile component are enclosed in the cavities formed by the interpenetrating giant molecules in such a manner that they cannot escape from their surroundings. The cage formers can be varied; complexes have been formed from benzene, thiophene, furan, pyrrole, phenol and other complexing agents. For a given cage, the type of entrapped molecule is determined by volume considerations and not by chemical nature, so the formation of clathrate compounds is a physical phenomenon rather than a chemical interaction.

The complexes, once formed, are very stable. For an enclosed molecule to leave its cage, it must overcome the attraction between itself and the cage. In the case of a large cage and a small enclosed molecule, even if there is no attraction, when the enclosed molecule approaches a possible small exit, its outward passage is opposed by the repulsive forces which arise when any two molecules closely approach one another. If the molecules forming the cage are subject to strong mutual attraction, they will not be pushed apart readily, and if the holes of exit are sufficiently small, the enclosed molecule will be repelled inwards if it attempts to escape. Powell[19] reasons that there will be a lower as well as an upper limit to the size of the enclosed molecule. An oversize molecule could not, of course, be enclosed in the cage, and a sufficiently small molecule would be able to escape through the holes without meeting the inward repulsion necessary for the stability of the complex. It might have been supposed that the various molecules enclosed by quinol, for example, were attached to the framework, perhaps by hydrogen bonds, but if this were the explanation, water should be more firmly attached than some other molecules, such as hydrogen sulfide. The physical concept of cages explains why water actually does not form a complex with quinol.

The clathrate complexes may be destroyed by any process which destroys the framework. The sulfur dioxide-quinol complex, for example, may be destroyed by addition in the cold of liquids that dissolve quinol, by melting the crystals, or to a small extent, by crushing. The fact that a small fraction of the enclosed molecules can be released by crushing is further verification of the physical concept of structure. Crystals of the sulfur dioxide-quinol complex have been kept loosely corked for years and appear to last indefinitely when freely exposed to air, but upon being ground, they liberate enough sulfur dioxide to be detected by smell. Based on known dimensions of crystal structure, Powell[19] has calculated that if crystals are crushed to cubes with an average side dimension of 10^{-3} centimeter, neglecting initial surface, the amount of complex decomposed will be of the order of 0.1 percent.

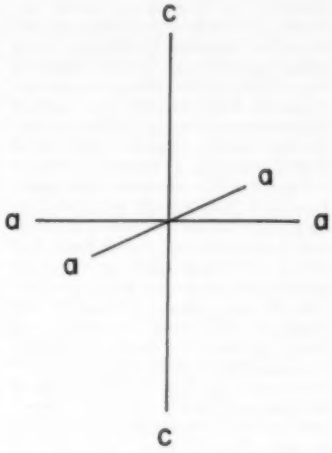

Figure 4. Tetragonal Crystal System.

Twenty-five years ago, Caspari[7,8] noted a difference in the crystal structures of quinol, depending upon the solvent from which it was crystalized. The crystals from aqueous media, he termed α-quinol, and those from a methyl alcoholic medium, he termed β-quinol. Palin and Powell[16,17] have recently conclusively shown that what Caspari termed β-quinol is actually a clathrate compound of quinol and methanol. Palin and Powell have now designed as β-quinol that special form consisting of two interpenetrating quinol frameworks with vacant cavities.

During the early phases of the work with clathrate compounds, it was found that high pressures made possible the formation of complexes which would not form at ordinary pressures because of the low solubility of gaseous reactants. This suggested the possibility of forming complexes with some of the inert gases, and such complexes have already been formed. Considering the nature of the crystalline complexes, the procedure for their preparation is relatively simple. The general method of preparation of the argon

complex,[20] for example, consists of making an aqueous or ethanol solution of quinol saturated at room temperature, placing this in a steel pressure vessel together with an additional portion of quinol approximately equal in weight to the desired yield of complex, purging out atmospheric gases and applying a pressure of argon from a cylinder (e.g., 600-1000 psi), raising the temperature by heating the vessel in a large water bath, and then allowing the solution in the pressure vessel to crystallize by slow cooling. The argon pressure may be maintained in the vessel by suitable additions from a cylinder. The quantity of quinol added is such that it will dissolve when the temperature is raised. A high pressure of argon is used in order to increase the solubility of the gas in the solution. The clathrate compound may be visualized as being formed by arranging for an argon atom to be available in position at the surface of the growing crystal whenever a cage of quinol molecules links up through its hydrogen bonds; accordingly, slow cooling is employed to prevent local impoverishment of the solution with respect to argon which would result in many of the cages being formed by quinol without entrapping argon molecules. The pressure is not required to prevent dissociation of the complex, since once the crystalline complex is formed, it may be handled at room temperature. In a series of preparations made with pressures up to 40 atmospheres, the product of highest argon content had the composition $3C_6H_4(OH)_2 \cdot 0.8A$, which corresponds to an argon content equivalent to a pressure of about 73 atmospheres. Based on reasoning and calculations presented by Powell,[20] this would mean that a volume of 100 cubic centimeters of the crystalline argon complex would contain over 7000 cubic centimeters of argon gas measured at standard conditions of temperature and pressure. The argon gas may be liberated from the clathrate compound by heating the crystals or by dissolving them in water or some other solvent which will dissolve the quinol framework.

Powell[21,22] has also prepared clathrate compounds of krypton and xenon. Attempts to form a helium complex with quinol have so far proved to be unsuccessful, and Powell predicts that this complex cannot be formed, since the helium atom, because of its small effective size, could escape through holes in the cage-like framework of β-quinol. In the case of the inert gas complexes which can be formed, it appears that they may serve as a portable source of inert gas in a form which may be easily handled and

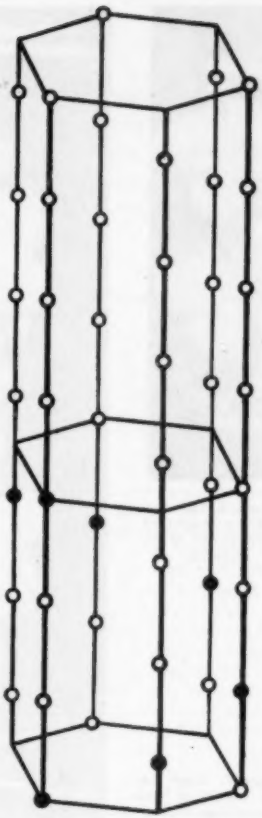

Figure 5. Lattice Arrangement of Hexagonal System of Urea Complex.

which does not require expensive steel cylinders, especially for small quantities of gas.

Several other clathrate type molecular complexes have been studied by Powell and co-workers,[15,24] including $Fe(CNCH_3)_4Cl_2 \cdot 3H_2O$, and the type $Ni(CN)_2 \cdot NH_3 \cdot M$, where M may be benzene, thiophene, phenol and other derivatives of benzene. Evans et al.[9] have made use of the latter type of complex in a method for obtaining pure benzene much more easily than by using prolonged fractionation in an efficient still, or by resorting to the tedious and wasteful process of fractional crystallization and fusion.

The molecular ratio between the complexing agent and the reactant molecule is a function of the number of cavities available. In an extensive study of the β-quinol complexes, Palin and Powell[17] report that these have the ideal formula $3C_6H_4(OH)_2 \cdot M$, where M may be hydrogen sulfide, methanol, hydrogen chloride, sulfur dioxide, carbon dioxide, methyl cyanide and others. Generally, the M is not present in the complex in ideal amount; it may approach the ideal value, e.g., 0.99 for methyl cyanide and 0.97 for methanol, but it never exceeds it. X-ray investigations indicate that the larger enclosed molecules produce minor alterations in the shape of the unit cell. In order to accommodate these larger non-spherical molecules, the quinol framework may become distended along one direction of the hexagonal cell and be simultaneously contracted at right angles by an effect analogous to the extension of a piece of trellis without alteration in the dimensions of its component parts.

A general summary of the work reported so far concerning clathrate compounds is presented by Smith.[29,70] Further work is in progress to learn more about this type of complex, and it is highly probable that the findings which have already been reported will find uses on both laboratory and industrial scales. The elucidation of the structure of these complexes will simplify more extensive investigations of other molecular complexes.

Theory of Urea Adduct Formation

Returning now to a consideration of urea adducts, it can be stated that in general, urea forms complexes only with straight-chain, or essentially straight-chain, compounds. The known complexes include paraffin hydrocarbons, ketones, organic acids, esters, unsaturated hydrocarbons, halides and other substituted compounds. However, this does not exhaust the list of possible reactants. There is a minimum chain length required for adduct formation, and this minimum is dependent upon the chemical classification or the physical shape of the reactant. For paraffins, the minimum chain length is six carbons; for monobasic acids, butyric acid is the lowest homolog to form a complex (formic acid reacts with urea, but this involves a chemical bonding through interaction of the acid with one of the NH_2 groups). With ketones, the lowest member is acetone, the first member of the series.

Schlenk[31] points out that neither isooctane nor 3-methyl heptane add to urea; however, 3-methyl eicosane, with its long unbranched zone, adds without any difficulty. Benzene does not add to urea, but if the octadecane radical is substituted onto benzene, octadecyl benzene does form an adduct. Thus, only the shorter branched compounds are ruled out entirely. In general, as the chain length increases, the ease of adduct formation also increases. As might be expected, in a mixture of cetane and heptane, the cetane is pref-

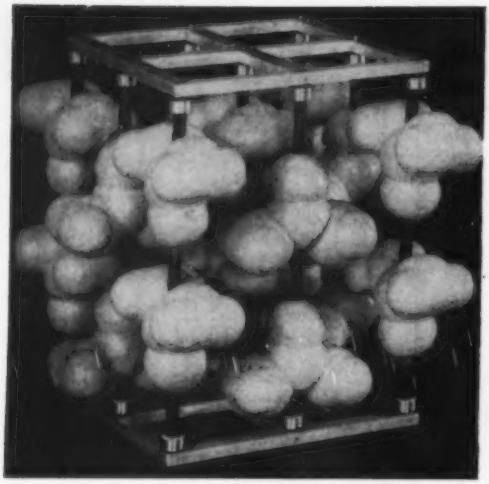

Figure 6. (above) Lattice Model of Tetragonal Urea Crystal.

Figure 7. (right) Lattice Model of Hexagonal Urea Adduct.

erentially included in the adduct; thus, if an insufficient amount of urea is present in a mixture, much more cetane than heptane will be in the adduct. Among the alkyl halides, 1-bromohexane forms an urea adduct, whereas 2-bromooctane does not; the bromine atom behaves in a manner analogous to a methyl group. But 2-2-difluorooctane does form an adduct; in explanation, Zimmerschied et al.[38] point out that here the small fluorine atom resembles hydrogen in size and does not prevent adduct formation.

Composition of Urea Adducts

The partners in the urea adducts are not united in whole numbered ratios except in a few instances, by chance. Several methods of analysis can be used for these complexes. The urea content of the crystals may be established by nitrogen determination, or the amount of organic component may be determined by carbon content or by weight loss upon dissociation of the adduct. Schreinemakers' wet residue method, which involves analysis of both the unwashed precipitate and the mother liquor, is used in many cases. Also, concentration changes in the reaction liquid may be determined for some liquid mixtures.

Some of the data obtained by Redlich et al.[26] are listed in Table 1. The results reported by Schlenk[31] and by Zimmerschied et al.[38] are in reasonably good agreement with these data. In some cases, Schlenk reports several values which differ among themselves, depending upon the method of preparation. Most discrepancies in the data can probably be attributed to incomplete reaction or to occlusion of a small amount of urea solution on the crystals of the complex.

The data on composition of the adducts can be presented in graphical form. Redlich et al.[26] present a graph for *n*-paraffins, as shown in Figure 1, which relates molal ratio and the number of carbon atoms. Schlenk[31] presents a similar curve, except that he relates molal ratio to the ideal stretched length of the reactant, as shown in Figure 2. By ideal chain length, Schlenk means the interval between the "spheres of action" of the end members of the chain. This distance is slightly greater than the interval between the mid-points of the first and last atoms. The sphere of action is a variable quantity, depending upon the class of compounds; for example, the effect of a carboxyl group is different from that of a hydroxyl or chloride radical.

TABLE 1
Composition of Urea Complexes (Urea/Reactant)

REACTANT	Molal Ratio	Weight Ratio
Methyl Ethyl Ketone	3.78	3.15
Adipic Acid	5.3	2.2
n-Heptane	6.1	3.7
n-Octane	6.73	3.54
Octene-1	6.3	3.4
Octanol-1	6.7	3.1
n-Nonane	7.4	3.47
n-Decane	8.1	3.4
Decene-1	7.8	3.3
Dodecane	9.3	3.3
Hexadecane	11.95	3.2
Hexadecene-1	12.0	3.2
Oleic Acid	12.2	2.6
Methyl Stearate	14.8	3.0
Methyl Oleate	14.5	2.9

A straight line is obtained for both of the methods of plotting shown in Figures 1 and 2. The only difference which should result from the two methods is in the slope of the line. The advantage in using the ideal lengths of the reactant molecules is that the data for various classes of compounds are converted to the same basis, and a just comparison between different classes of compounds can be made. Schlenk found that the data for all classes of compounds, when plotted as shown in Figure 2, lie very close to a straight line through the points. Thus, of course, the slopes of all plots relating molal ratios and ideal chain

lengths are the same for all classes of compounds.

Inasmuch as the adducts did not have molecular stoichiometric values, it was realized that the volume or size of the reactant molecule must play a significant part in adduct formation. Nearly all of the adducts which had been observed had crystallized into long hexagonal prisms or flat hexagonal plates. It was anticipated that X-ray studies would give additional information concerning the adducts, and this proved to be true.

X-ray powder diffraction patterns have been obtained for many different urea complexes. Extensive investigations have been conducted using the cetane-urea adduct, which is stable and easily handled at ordinary temperatures. Further work has been carried out with many different complexes, and because of the uniformity of the X-ray powder diffraction patterns, it can be definitely concluded that the organic component in the adduct does not make any contribution to the interference photograph.

Almost identical results were obtained by two independent laboratories. The crystal has a hexagonal unit cell, with the faces referred to axes as shown in Figure 3. Schlenk[31] reports that Hermann found the dimensions $a = 8.20$ Angstrom units and $c = 11.1$ Angstrom units, and Smith[28] found the values to be $a = 8.24$ Angstrom units and $c = 11.0$ Angstrom units. There are six urea molecules in the unit cell, and they form spirals in constituting the unit cell. This arrangement is shown in Figure 5, with the six molecules of the elementary cell represented as solid; the other molecules, which are represented as circles, belong to the six surrounding prisms. On a time average, the superposed urea molecules are oriented clockwise 120° with respect to one another. In this molecular arrangement, there results what Schlenk[31] describes as a "Hohlraum," or "canal," into which the reacting molecule must fit. X-ray studies of the pure urea crystal[14] indicate that it has a tetragonal structure, with the faces referred to axes as shown in Figure 4. This is a close-packed crystal, with the urea molecules oriented as shown in Figure 6, and there is no canal or available free space in which other molecules may be enclosed. Thus, there is a crystal transformation from a tetragonal to a hexagonal system when the adduct is formed. In the adduct, the urea molecules are held together by spirals of hydrogen bonds between the oxygen atoms and the amide groups. This accounts in a large measure for the stability of the urea adduct.

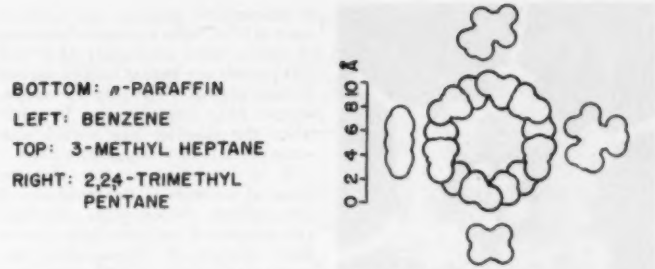

Figure 8. Cross-sections of Urea in Hexagonal System and Possible Reactant Molecules.

It is evident from the X-ray studies that spatial considerations enter into adduct formation. Figure 7 is a photograph of a molecular model, presented by Schlenk,[31] which shows the arrangement of the urea molecules in the hexagonal lattice of an adduct. The urea molecules in this model are represented by the known spheres of action of the constituent atoms. The vertical edge-axes pass through the oxygen atoms of the urea molecules. The model shows how the superposed molecules are turned 120° with respect to one another. The distance between two molecules lying one above another is 3.7 Angstrom units; the edge length of the unit cell is 4.8 Angstrom units. In this arrangement, the urea molecules constitute the walls of the canal into which the reactant molecules fit.

Schlenk reasons that if the cross-section, or end view, of a long molecule has a dimension greater than the limiting dimensions of the canal, the molecule cannot form an adduct. If the dimensions are such that a tight fit is provided, the adduct will form with difficulty, if at all. In this latter case, a closely fitting molecule can be assisted by some other molecule which reacts easily. Thus, 3-methyl heptane, whose dimensions provide a close fit, reacts easily when mixed with a normal paraffin of more than six carbons. Benzene, with its close fit, will not form an adduct, but octadecyl benzene reacts readily. Similarly, 3-methyl eicosane, with its long unbranched zone, reacts readily. On the other hand, isooctane, with its oversize cross-section, will not react with urea under any conditions. Thus, the canal must be able to receive the molecule before an adduct can form. Figure 8 shows cross-sections of the urea canal and of several possible reactant molecules. Below the canal is shown the cross-section of a normal paraffin, to the left is benzene, and on top is 3-methyl heptane; all of these molecules have dimensions which permit adduct formation. To the right of the canal is shown the cross-section of isooctane (2,2,4-trimethyl pentane), which has dimensions greater than those of the canal, so it cannot form an adduct. Figure 9 is a top view of the model presented in Figure 7, with a model of a normal paraffin in place in the canal.

A study of the elementary cell indicates that there are 1.87 Angstrom units of canal length per molecule of urea. Inasmuch as the lengths of the reactant molecules are known, or can be calculated, and the compositions of the adducts are known, a relationship can be obtained first, for the available canal length per molecule of reactant, and secondly, the utilized canal length per molecule of reactant. Schlenk presents plots showing available and utilized canal length as a function of the number of moles of urea per mole of reactant. In the case of paraffins, the lines are parallel, indicating a constant distance between the hydrocarbon molecules in the canal. It is found that there is a statistical average distance of 2.4 Angstrom units between the reactant molecules in the canal, regardless of the lengths of the reactants. One molecule of nonane, for example, corresponds by analysis to 7.6 molecules of urea. According to X-ray determinations, 7.6 molecules of urea have a canal length of 14.1 Angstrom units. The nonane molecule, in an ideal stretched out position, is 11.7. Angstrom units in length; this results in an interval of 2.4 Angstrom units between successive nonane molecules in the canal. This same value is also obtained for ketones and esters. In the case of free acids, primary alcohols, and primary hydroxyl halogenides, this value is not constant but decreases slightly with the size of the reactant molecule. Fetterly[11] points out that the calculated interval between successive reactant molecules in the canal is not actually an empty space but that it represents a van der Waals spacing.

Fetterly has further considered the

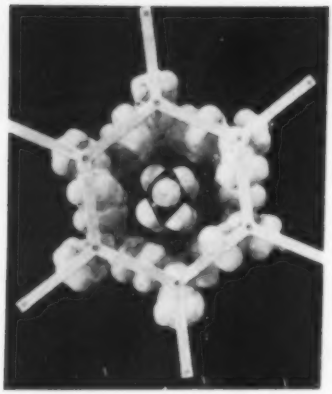

Figure 9. End View of Model of Adduct Showing Hexagonal Urea Lattice with *n*-Paraffin in Canal.

structure of these complexes. He states that the channel produced by the hexagonal urea lattice just fits the *n*-paraffin chain with a packing diameter of about 5.25 Angstrom units. When the end and side views of various molecules are compared with this dimension, as presented by Fetterly[11] and shown in Figure 10, many observed reactivities become apparent.

The presence of a rigid, non-rotative "cis" double bond along a fatty acid chain, as in oleic acid, creates a kink in the chain and interferes with its perfect linearity, resulting in a urea lattice of reduced stability. The linear channel strain increases as more "cis" double bonds are added to a chain. On the other hand, more linear acids, such as stearic acid, form relatively stable complexes. These differences in reactivity resulting from structural differences in the reactants serve as a basis for separation processes to be considered later.

Ionic molecules, such as *n*-octadecylsulfonic acid and its sodium soap, do not form urea complexes. Fetterly points out that this is true because of the strong tendency of these ions to solvate in aqueous solutions with the consequent inability of the solvated water and urea molecules to be drawn into a urea lattice.

Inasmuch as the application of pressure brought about reaction for clathrate compounds in cases where reactions did not occur at atmospheric pressure, it might be anticipated that pressure would influence the formation of urea adducts. Very little has been reported concerning the use of pressure for urea complexes, but Fetterly has made some observations favorable to this prediction. Pure liquid *n*-pentane, which does not form an adduct at atmospheric pressure, was made to react at 0° C. with a saturated solution of urea in water after applying 50 and 250 pounds per square inch of carbon dioxide pressure. The reaction was indicated by a large increase in solids when the solution was seeded with some crystals of cetane-urea adduct.

It is interesting to note that the physical concepts of the structures of urea adducts, choleic acids and clathrate compounds are analogous to structural concepts of certain other phenomena. Pauling[18] has reported that silica gels with high adsorptive capacity for specific chemicals may be "tailor made" by preparing them according to procedures analogous to the formation of antibodies. In the formation of antibodies, long "rope-like" molecules may be visualized as arranging themselves into shapes which neutralize or tie-up the harmful radicals or groups of antigens which are introduced into the animal system. After these antibodies are formed, they retain their specific shapes and are available to fit around any antigens with which they may later come in contact, provided they are of the same specific shape and design.

A recent review and discussion by Schlenk[3a,b] considers the relationships among urea and thiourea adducts, choleic acids, clathrate compounds and several other occlusion compounds. The occlusion compounds are defined as addition compounds in which one compound fits into and is surrounded by the crystal lattice of the other compound.

Proposed Mechanism for Fatty Acid-Urea Adduct Formation

The question may arise concerning whether urea adducts exist only in crystalline form or whether they can be found similarly associated in liquid form. Inasmuch as non-whole numbered mole ratios exist, it is naturally impossible to find such equivalent "molecules" in the liquid as, for example, 7.2 urea plus one octane. Schlenk points out that large aggregates, such as 36 urea and 5 octane, or multiples thereof, are not to be expected to exist independently, since the binding forces are too small for such large aggregates to hold together independently in liquid form. However, it is considered likely that small associations of changing compositions occur in the liquid phase preliminary to the strong associations in the crystals.

Evidence of the existence of such associations is demonstrated by the fact that water-insoluable adduct formers, such as cetane and stearic acid, are made soluble by the presence of urea; this is not the case for non-adduct formers. At 25° C., 100 parts of water will dissolve 12 parts of *n*-valeric acid; in a saturated solution of urea in water, *n*-valeric acid is miscible in all proportions. To show that this is not a case of interaction of the carboxyl group with urea, the isomer, α-methyl butyric acid, which is a non-adduct former, is no more soluble in a urea solution than in water.

Additional evidence to show that a molecular order between urea and reactant must exist in the liquid phase is shown by the following equations:

$$1\ \text{Urea} + 34\ n\text{-butyric acid} \rightarrow 1\ \text{Urea in solution} + 95\ \text{cal.} \quad (1)$$

$$1\ \text{Urea} + 34\ \text{isobutyric-acid} \rightarrow 1\ \text{Urea in solution} - 137\ \text{cal.} \quad (2)$$

The solution of urea in a solvent is normally an endothermic process, as in Equation (2). In Equation (1), since heat is evolved upon solution, there is evidence of interaction in the liquid phase.

In connection with his study of fatty acid-urea complexes, Fetterly[11] has proposed the following mechanism for the reaction between urea and stearic acid for the formation of adducts in an aqueous medium. This postulation is a general confirmation of the proposal by Schlenk of the existence of some sort of molecular order in the liquid phase.

When stearic acid dissolves in water, it dissociates into a monomeric unit which becomes solvated on the polar end with water molecules by hydrogen bond coordination. The paraffin chain induces a quasi-solid "husk" structure over its surface, estimated from heat of solution data to be approximately two molecules deep at 25° C. These husk molecules are bound to the chain by numerous van der Waals contacts and an induced hydrogen bonded network of water. The solvation of the paraffin chain gives rise to a linear configuration.

As urea is added to the water phase, some of the solvated chain molecules begin to form a urea rather than a water solvate husk. These become more numerous as the urea concentration is increased, and because of size and configuration factors, they are more soluble than the aqueous units. The polar group of the fatty acid can solvate with either urea or water, but the smaller water molecules have the best opportunity for coordination. When a critical concentration of these linear solvate units exists in solution, they will diffuse onto a seed crystal surface more rapidly than the rate of those dissolving, with the result that adduct crystals begin to appear.

When fatty acids form complexes

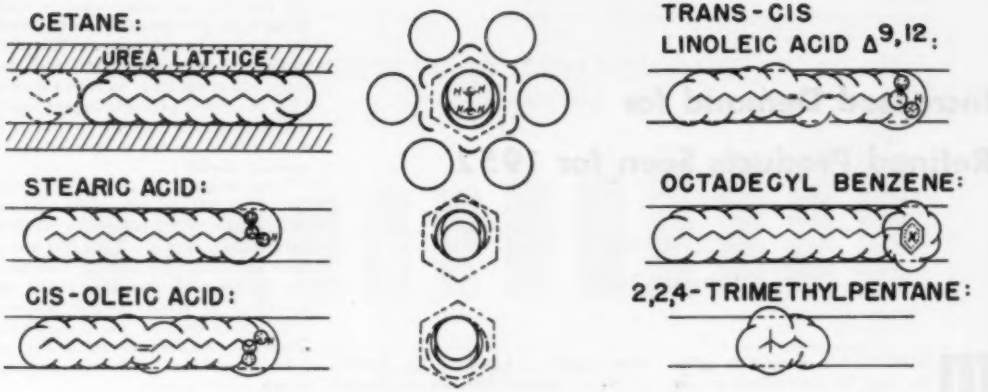

Figure 10. Comparison of Molecular Configuration with Urea Adduct Channel.

with urea, the acid molecules become oriented in pairs to form dimers in the adduct. Fetterly explains that since the solvate layer can be larger than a single molecule in thickness, adherence of the monomeric unit to the crystal surface must generally involve a net loss in urea molecules. The gain in lattice energy from increased interpenetration of the spiraling urea network and greater linearity of the chain cause the solvate sphere to drop from the polar groups to produce a dimer in the crystal. Because of this dimerization, a *n*-fatty acid will form a more stable adduct in water solutions than the corresponding *n*-paraffin, despite a poorer packing around the carboxyl group and its tendency to solvate. For example, cetane (n-$C_{16}H_{34}$) is equivalent to lauric acid (n-$C_{11}H_{23}COOH$) in adduct stability. This results from dimerization of the fatty acid in the adduct which increases the effective chain length by replacing a van der Waals bond by two hydrogen bonds.

The lowest members of the *n*-paraffin and fatty acid series observed to produce complexes with a saturated solution of urea in water at atmospheric conditions are *n*-hexane and *n*-caproic acid (n-$C_5H_{11}COOH$). When solid urea is used, the reactivity of the acid extends to *n*-butyric acid. By extrapolation of heat of reaction data, Schlenk[31] predicted that propionic acid should form a complex, but none was ever observed. Fetterly points out that the lack of reaction of this member can be explained by its tendency to self-solvate and form trimers and also to produce a 1:2 compound with urea, thus preventing the formation of an urea adduct.

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Increased Demand for Refined Products Seen for 1952

CECIL W. SMITH

Economics Editor

HIGHER levels of refining activity must be maintained by the United States petroleum industry during 1952 to meet projected demand for its products. The year just concluded made the greatest call on refiners' output of any comparable period, but 1952 must see the nation's plants increase thruput by approximately 4 percent to keep pace. This computation is based on the Bureau of Mines' annual forecast of demand for petroleum products.

Refinery stills must be charged with an average of 6,760,000 barrels of crude daily during 1952, which would be an increase of 264,000 barrels a day or 4.1 percent over the 6,496,000 barrels run daily last year. This hike in operations is expected to be slightly less than the percentage gain in total demand for petroleum which has been estimated to be 5.1 percent. This disparity in processing rates and demand will result from an increase over 1951 in refined products import rates, relatively greater gasoline output, and a slow-down in the accumulation of product stocks.

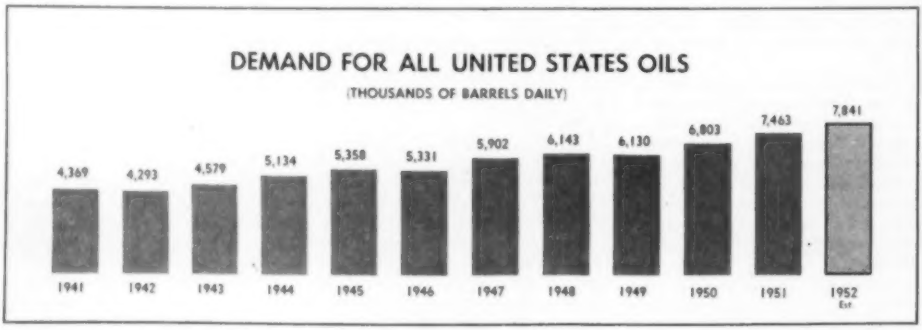
Total demand for all oils will average 7,841,000 barrels daily during 1952, a gain of 5.1 percent or 378,000 barrels daily over the 7,463,000 a day used in 1951, the bureau forecasts. An increase of that size might be described as about normal, whereas 1951's total demand was a somewhat abnormal 660,000 barrels a day or 9.7 percent over daily consumption in the previous year.

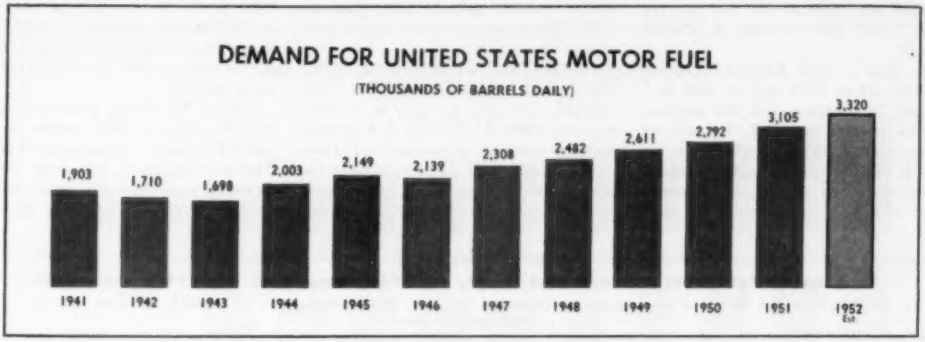
Growth in demand should be smaller in 1952 than in 1951 because of sharp cutbacks in exporting rates, which climbed precipitously during 1951, due to the shutdown of Iran's oil industry. Total U. S. refined product exports in 1952 are forecast at 259,000 barrels, a decline of 25.8

Demand for All Oils
(All Figures in Barrels)

YEAR	TOTAL (Domestic and Export)		DOMESTIC		EXPORTS	
	Annual Total	Daily Average	Annual Total	Daily Average	Annual Total	Daily Average
1918						
1919	438,434,000	1,201,200	374,541,000	1,026,100	63,893,000	175,100
1920	535,382,000	1,462,800	456,764,000	1,245,300	79,618,000	217,500
1921	592,402,000	1,450,400	457,521,000	1,253,300	71,881,000	196,900
1922	605,540,000	1,659,000	530,990,000	1,454,800	74,550,000	204,200
1923	754,361,000	2,066,700	652,027,000	1,786,400	102,334,000	280,300
1924	805,070,000	2,199,600	687,742,000	1,879,100	117,328,000	320,500
1925	840,818,000	2,303,600	726,797,000	1,991,200	114,021,000	312,400
1926	913,893,000	2,501,100	780,487,000	2,138,300	132,406,000	362,800
1926	944,762,000	2,588,400	802,499,000	2,198,600	142,263,000	389,800
1928	1,014,716,000	2,772,400	859,759,000	2,349,000	154,957,000	423,400
1929	1,103,203,000	3,022,500	940,083,000	2,575,600	163,120,000	446,900
1930	1,083,511,000	2,968,500	927,016,000	2,539,800	156,495,000	428,700
1931	1,037,274,000	2,814,500	902,920,000	2,473,800	134,354,000	340,700
1932	938,757,000	2,564,900	835,482,000	2,282,700	103,275,000	282,200
1933	975,214,000	2,671,800	868,487,000	2,379,400	106,727,000	292,400
1934	1,034,672,000	2,834,700	920,165,000	2,521,000	114,507,000	313,700
1935	1,112,672,000	3,048,400	983,685,000	2,695,000	128,987,000	353,400
1936	1,224,748,000	3,346,300	1,092,754,000	2,985,700	131,994,000	360,600
1937	1,342,516,000	3,678,100	1,169,682,000	3,204,600	172,834,000	473,800
1938	1,330,850,000	3,646,200	1,137,122,000	3,115,400	193,728,000	530,800
1939	1,420,035,000	3,890,500	1,231,967,000	3,372,500	188,959,000	517,700
1940	1,457,086,000	3,981,100	1,326,620,000	3,624,600	130,466,000	356,500
1941	1,594,609,000	4,368,800	1,485,779,000	4,070,600	108,830,000	298,200
1942	1,566,815,000	4,292,600	1,449,908,000	3,972,300	116,907,000	320,300
1943	1,671,383,000	4,579,100	1,521,426,000	4,168,300	149,957,000	410,800
1944	1,878,879,000	5,133,600	1,671,263,000	4,566,300	207,616,000	567,300
1945	1,955,668,000	5,358,000	1,772,685,000	4,856,700	182,983,000	501,300
1946	1,945,909,000	5,331,200	1,792,786,000	4,911,700	153,123,000	419,500
1947	2,154,280,000	5,902,100	1,989,803,000	5,451,500	164,477,000	450,600
1948	2,248,352,000	6,143,000	2,113,678,000	5,775,100	134,674,000	368,000
1949	2,237,626,000	6,130,500	2,118,250,000	5,803,400	119,376,000	327,100
1950	2,483,119,000	6,803,100	2,372,084,000	6,498,900	111,035,000	304,200
1951	2,724,018,000	7,463,000	2,568,080,000	7,035,800	155,938,000	427,200
*1952	2,870,000,000	7,841,500	2,757,000,000	7,532,800	113,000,000	308,700

Source: U. S. Bureau of Mines, except November and December, 1951, estimated with aid of A.P.I. Reports. * Forecast.





Demand for Motor Fuel
(All Figures in Barrels)

YEAR	TOTAL (Domestic and Export)		DOMESTIC		EXPORTS		YEAR	TOTAL (Domestic and Export)		DOMESTIC		EXPORTS	
	Annual Total	Daily Average	Annual Total	Daily Average	Annual Total	Daily Average		Annual Total	Daily Average	Annual Total	Daily Average	Annual Total	Daily Average
1918	93,599,000	256,400	79,949,000	219,000	13,650,000	37,000	1936	510,252,000	1,394,100	481,606,000	1,315,800	28,646,000	78,300
1919	97,790,000	267,900	88,648,000	242,900	9,142,000	25,000	1937	557,658,000	1,527,800	519,352,000	1,422,900	38,306,000	104,900
1920	124,623,000	340,500	108,945,000	297,700	15,678,000	42,800	1938	573,112,000	1,570,200	523,003,000	1,432,900	50,109,000	137,300
							1939	600,147,000	1,644,200	555,509,000	1,521,900	44,638,000	122,300
1921	130,203,000	356,700	116,840,000	320,100	13,363,000	36,600	1940	614,867,000	1,679,900	589,490,000	1,610,600	25,377,000	69,300
1922	152,132,000	416,800	137,770,000	377,500	14,362,000	39,300							
1923	195,556,000	535,800	174,462,000	478,000	21,094,000	57,800	1941	694,568,000	1,903,000	667,505,000	1,828,800	27,063,000	74,200
1924	225,737,000	616,800	196,586,000	537,100	29,151,000	79,700	1942	624,207,000	1,710,200	589,110,000	1,614,000	35,097,000	96,200
1925	264,429,000	724,500	232,745,000	637,700	31,684,000	86,800	1943	619,815,000	1,698,100	568,238,000	1,556,800	51,577,000	141,300
							1944	733,019,000	2,002,800	632,482,000	1,728,100	100,537,000	274,700
1926	311,897,000	854,500	268,128,000	734,600	43,769,000	119,900	1945	784,392,000	2,149,000	696,333,000	1,907,800	88,059,000	241,200
1926	350,318,000	959,800	305,367,000	836,600	44,951,000	123,200							
1928	392,293,000	1,071,800	338,881,000	925,900	53,412,000	145,900	1946	780,751,000	2,139,000	735,417,000	2,014,800	45,334,000	124,200
1929	444,937,000	1,219,000	382,575,000	1,049,000	62,089,000	170,000	1947	842,464,000	2,308,100	795,015,000	2,178,100	47,449,000	130,000
1930	463,184,000	1,269,000	397,609,000	1,089,300	65,575,000	179,700	1948	908,572,000	2,482,400	871,270,000	2,380,500	37,302,000	101,900
							1949	953,060,000	2,611,100	913,713,000	2,503,300	39,347,000	107,800
1931	453,559,000	1,242,600	407,843,000	1,117,400	45,716,000	125,200	1950	1,018,997,000	2,791,800	994,412,000	2,724,400	24,585,000	67,400
1932	413,229,000	1,129,000	377,791,000	1,032,200	35,438,000	96,800							
1933	409,815,000	1,122,800	380,494,000	1,042,500	29,321,000	80,300	1951	1,133,208,000	3,104,700	1,093,267,000	2,995,300	39,941,000	109,400
1934	435,025,000	1,191,800	410,339,000	1,124,200	24,686,000	67,600	*1952	1,215,000,000	3,319,700	1,187,000,000	3,243,300	28,000,000	76,500
1935	465,423,000	1,275,100	434,810,000	1,191,200	30,613,000	83,900							

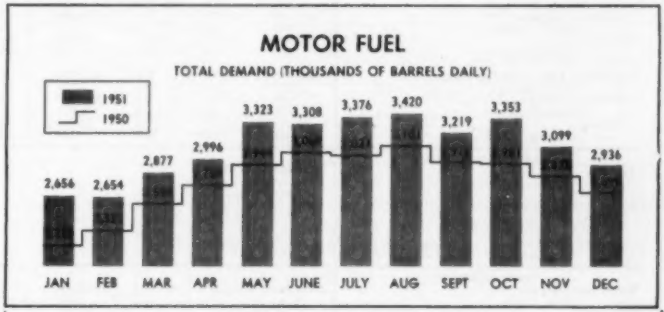
Source: U. S. Bureau of Mines, except November and December, 1951, estimated with aid of A.P.I. reports. * Forecast.

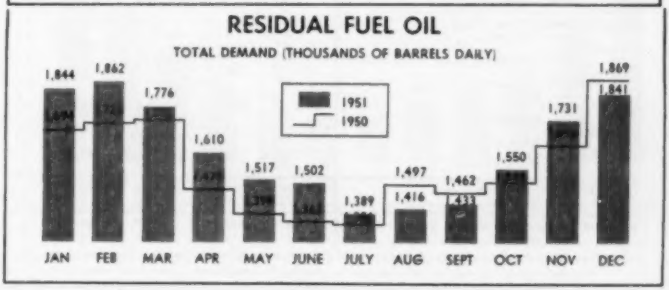
percent from the 349,000 barrels exported daily in 1951. The latter volume represented an increase of 67 percent over the exports of 209,000 barrels per day in 1950. The decreases in daily average exports of refined products in 1952 will include declines of 30 percent for motor fuel, 38.1 percent for kerosine, 22.2 percent for distillate fuel oil, and 32.9 percent for residual fuel oil.

Motor Fuel Estimate

With exports down, motor fuel total demand, domestic and export, will increase only 6.9 percent in 1952 after rising 11.2 percent in 1951. But domestic demand of 3,243,000 barrels daily in 1952 will be 8.3 percent over the 2,995,000 daily of 1951, which was 9.9 percent over the 2,725,000 daily of 1950.

Total daily requirements for kerosine will increase only 5.4 percent in 1952, compared with a 8.1 percent hike during 1951. Domestic use of 361,000 barrels a day this year will be 8.1 percent over the 334,000 con-





sumed daily in 1951, which had represented an increase of 3.5 percent above 1950's daily average of 323,000 barrels.

The gain in total demand for distillate fuel oil in 1952 will be held to 7 percent, in contrast with the increase of 15.7 percent in 1951, because of lower exports and a slowing down in growth of domestic useage. Domestic requirements of 1,333,000 barrels daily will be 8.5 percent more than the 1,228,000 consumed in 1951, which was 13.6 percent more than the 1,081,000 barrels daily the nation used a year previously.

Residual fuel oil demand of 1,626,000 barrels daily forecast for 1952 would be virtually the same as in 1951, whereas 1951 had shown a 4 percent increase over its previous year. Lowered exports will be responsible for the failure to show more than a nominal increase, as domestic requirements of 1,571,000 barrels daily in 1952 would be 2.1 percent above the 1,539,000 daily needed in 1951. That amount had been 24,000 barrels a day or 1.6 percent over the 1,515,000 used daily in 1950.

Except for being generally higher in 1952 than in 1951, motor fuel demand followed normal seasonal trends. The low points of the year were in January and February when demand averaged 2,655,000 barrels daily. As

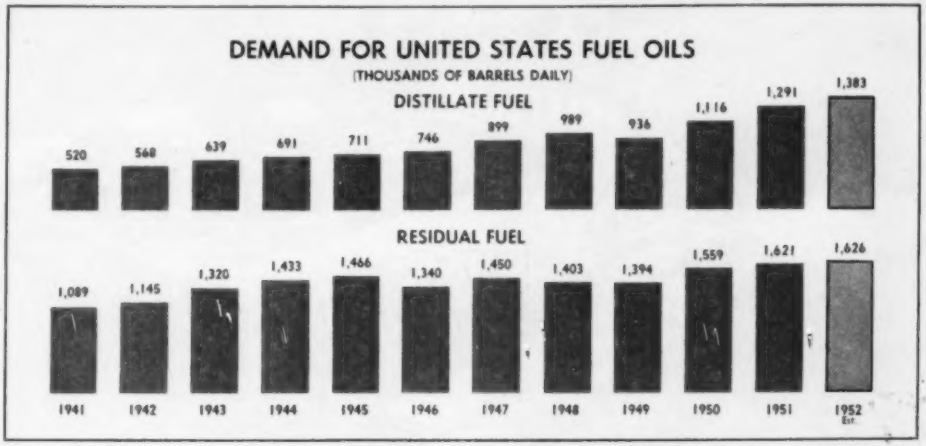
Forecast of Petroleum Demand and Supply in 1952, Compared With 1951 and 1950

All data from U. S. Bureau of Mines except November and December, 1951, estimated with aid of A.P.I. statistical bulletins.

(THOUSANDS OF BARRELS)

ITEM	ANNUAL COMPARISONS					1952 FORECAST BY QUARTERS			
	1950	1951	% Diff. '50-'51	1952 Forecast	% Diff. '51-'52	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
DEMAND									
All Oils, Total Demand	**2,483,119**	**2,724,018**	+ 9.7	**2,870,000**	+ 5.4	**745,000**	**679,000**	**688,000**	**758,000**
(Daily Average)	6,803	7,463	+ 9.7	7,841	+ 5.1	8,187	7,462	7,478	8,239
Domestic Demand	2,372,084	2,568,080	+ 8.3	**2,757,000**	+ 7.4	708,000	646,000	665,000	738,000
(Daily Average)	6,499	7,036	+ 8.3	**7,533**	+ 7.1	7,780	7,099	7,228	8,022
Exports, Total	111,035	155,938	+ 40.4	**113,000**	— 27.5	37,000	33,000	23,000	20,000
(Daily Average)	304	427	+ 40.4	**308**	— 27.9	407	363	250	217
Crude Exports	34,798	28,599	— 17.8	**18,000**	— 37.1	5,000	5,000	4,000	4,000
(Daily Average)	95	78	— 17.8	**49**	— 37.2	55	55	43	43
Refined Exports	76,237	127,339	+ 67.0	**95,000**	— 25.4	32,000	28,000	19,000	16,000
(Daily Average)	209	349	+ 67.0	**259**	— 25.8	352	308	207	174
Motor Fuel, Total Demand	**1,018,997**	**1,133,208**	+ 11.2	**1,215,000**	+ 7.2	**266,000**	**317,000**	**328,000**	**304,000**
(Daily Average)	2,792	3,105	+ 11.2	**3,320**	+ 6.9	2,923	3,484	3,565	3,304
Domestic Demand	994,412	1,093,267	+ 9.9	**1,187,000**	+ 8.6	257,000	309,000	322,000	299,000
(Daily Average)	2,725	2,995	+ 9.9	**3,243**	+ 8.3	2,824	3,396	3,500	3,250
Exports	24,585	39,941	+ 62.5	**28,000**	— 29.9	9,000	8,000	6,000	5,000
(Daily Average)	67	110	+ 62.5	**77**	— 30.0	99	88	65	54
Kerosine, Total Demand	**119,922**	**129,639**	+ 8.1	**137,000**	+ 5.7	**47,000**	**23,000**	**23,000**	**44,000**
(Daily Average)	329	355	+ 8.1	**374**	+ 5.4	517	253	250	478
Domestic Demand	117,846	122,025	+ 3.5	**132,000**	+ 8.2	44,500	21,500	22,500	43,500
(Daily Average)	323	334	+ 3.5	**361**	+ 8.1	489	236	244	473
Exports	2,076	7,614	+266.8	**5,000**	— 34.3	2,500	1,500	500	500
(Daily Average)	6	21	+266.8	**13**	— 38.1	28	17	6	5
Distillate Fuel Oil, Total Demand	**407,276**	**471,249**	+ 15.7	**506,000**	+ 7.4	**171,000**	**96,000**	**91,000**	**148,000**
(Daily Average)	1,116	1,291	+ 15.7	**1,382**	+ 7.0	1,879	1,055	989	1,609
Domestic Demand	394,697	448,242	+ 13.6	**488,000**	+ 8.9	164,000	90,000	88,000	146,000
(Daily Average)	1,081	1,228	+ 13.6	**1,333**	+ 8.5	1,802	989	957	1,587
Exports	12,579	23,007	+ 82.9	**18,000**	— 21.8	7,000	6,000	3,000	2,000
(Daily Average)	35	63	+ 82.9	**49**	— 22.2	77	66	32	22
Residual Fuel Oil, Total Demand	**569,171**	**591,768**	+ 4.0	**595,000**	+ 0.5	**165,000**	**137,000**	**134,000**	**159,000**
(Daily Average)	1,559	1,621	+ 4.0	**1,626**	+ 0.3	1,813	1,505	1,457	1,728
Domestic Demand	552,944	561,721	+ 1.6	**575,000**	+ 2.4	158,000	131,000	130,000	156,000
(Daily Average)	1,515	1,539	+ 1.6	**1,571**	+ 2.1	1,736	1,440	1,413	1,696
Exports	16,227	30,437	+ 85.2	**20,000**	— 33.4	7,000	6,000	4,000	3,000
(Daily Average)	44	82	+ 85.2	**55**	— 32.9	77	65	44	32
***All Other Oils, Total Demand**	**367,753**	**398,154**	+ 8.3	**417,000**	+ 4.7	**96,000**	**106,000**	**112,000**	**103,000**
(Daily Average)	1,007	1,091	+ 8.3	**1,139**	+ 4.4	1,055	1,165	1,217	1,120
Domestic Demand	312,185	342,825	+ 9.8	**375,000**	+ 9.4	84,500	94,500	102,500	93,500
(Daily Average)	855	939	+ 9.8	**1,025**	+ 9.2	929	1,038	1,114	1,016
Exports	55,568	55,329	— 0.4	**42,000**	— 24.1	11,500	11,500	9,500	9,500
(Daily Average)	152	152	— 0.4	**114**	— 25.0	126	127	103	104
CHANGE IN STOCKS									
All Oils	**—20,409**	**+33,354**	.....	.....	.....	**—40,000**	**+28,000**	**+36,000**	**—24,000**
(Daily Average)	—56	+91	.....	.....	.....	—439	+307	+392	—260
Crude Oil	—4,893	+7,764	.....	.....	.....	.....	.....	.....	.....
(Daily Average)	—13	+21	.....	.....	.....	.....	.....	.....	.....
Natural Gasoline	+524	+1,045	.....	.....	.....	.....	.....	.....	.....
(Daily Average)	+1	+3	.....	.....	.....	.....	.....	.....	.....
Refined Products	—16,040	+24,545	.....	.....	.....	—40,000	+28,000	+36,000	—24,000
(Daily Average)	—44	+67	.....	.....	.....	—439	+307	+392	—260
NEW SUPPLY									
Total New Supply	**2,462,710**	**2,757,372**	+ 12.0	**2,870,000**	+ 4.1	**705,000**	**707,000**	**724,000**	**734,000**
(Daily Average)	6,747	7,554	+ 12.0	**7,841**	+ 3.8	7,748	7,769	7,870	7,979
Domestic Production, Total	**2,153,561**	**2,450,140**	+ 13.8	**2,536,000**	+ 3.5	**626,000**	**628,000**	**640,000**	**642,000**
(Daily Average)	5,900	6,713	+ 13.8	**6,929**	+ 3.2	6,880	6,901	6,957	6,979
Crude Oil	1,971,845	2,244,404	+ 13.8	**2,319,000**	+ 3.3	572,000	575,000	586,000	586,000
(Daily Average)	5,402	6,149	+ 13.8	**6,336**	+ 3.0	6,286	6,319	6,370	6,370
Other Oils	181,716	205,736	+ 13.2	**217,000**	+ 5.5	54,000	53,000	54,000	56,000
(Daily Average)	498	564	+ 13.2	**593**	+ 5.1	594	582	587	609
Imports, Total	**309,149**	**307,232**	— 0.6	**334,000**	+ 8.7	**79,000**	**79,000**	**84,000**	**92,000**
(Daily Average)	847	842	— 0.6	**912**	+ 8.3	868	868	913	1,000
Crude Oil	177,714	179,425	+ 1.0	**194,000**	+ 8.1	45,000	47,000	50,000	52,000
(Daily Average)	487	492	+ 1.0	**530**	+ 7.7	494	516	543	565
Refined Products	131,435	127,807	— 2.8	**140,000**	+ 9.5	34,000	32,000	34,000	40,000
(Daily Average)	360	350	— 2.8	**382**	+ 9.1	374	352	370	435
Crude Oil Runs to Stills, Total	**2,094,867**	**2,371,168**	+ 13.2	**2,474,160**	+ 4.3	**607,880**	**612,430**	**625,690**	**628,360**
(Daily Average)	5,739	6,496	+ 13.2	**6,760**	+ 4.1	6,680	6,730	6,800	6,830
Demand for Domestic Crude, Total	**1,978,035**	**2,233,751**	+ 12.9	**2,318,976**	+ 3.8	**572,026**	**575,029**	**586,040**	**586,040**
(Daily Average)	5,419	6,120	+ 12.9	**6,336**	+ 3.5	6,286	6,319	6,370	6,370

* Includes crude oil used as fuel and lost in handling, liquefied gases, petroleum coke, asphalt, road oil, etc., and refinery losses.



Demand for United States Fuel Oils

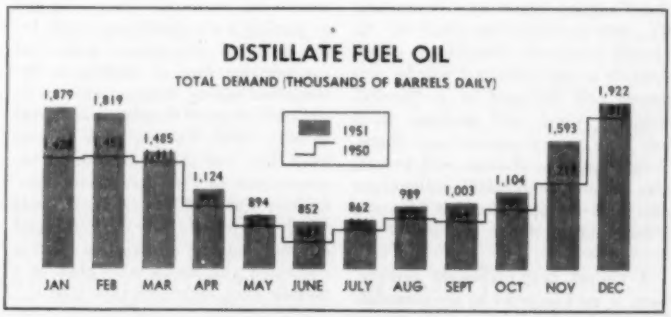
(All Figures in Barrels)

YEAR	TOTAL DEMAND (Domestic and Export)		DOMESTIC DEMAND		EXPORTS	
	Annual Total	Daily Average	Annual Total	Daily Average	Annual Total	Daily Average
All Fuel Oils (Distillate and Residual)						
1918	172,387,000	472,300	142,751,000	391,100	29,636,000	81,200
1919	180,290,000	494,000	163,803,000	448,800	16,487,000	45,200
1920	208,052,000	568,400	185,972,000	508,100	22,080,000	60,300
1921	218,332,000	598,100	195,656,000	536,000	22,676,000	62,100
1922	255,542,000	700,100	237,063,000	649,500	18,479,000	50,600
1923	294,760,000	807,500	261,388,000	716,100	33,372,000	91,400
1924	328,015,000	896,200	290,766,000	794,400	37,249,000	101,800
1925	343,092,000	940,000	307,004,000	841,100	36,088,000	98,900
1926	377,923,000	1,035,400	339,572,000	930,300	38,351,000	105,100
1927	386,656,000	1,059,300	339,265,000	929,500	47,391,000	129,800
1928	428,401,000	1,170,500	383,974,000	1,049,100	44,427,000	121,400
1929	454,207,000	1,244,700	415,156,000	1,137,400	39,151,000	107,300
1930	404,981,000	1,109,600	368,531,000	1,009,700	36,450,000	99,900
1931	363,899,000	997,000	334,668,000	916,900	29,231,000	80,100
1932	324,151,000	885,600	304,157,000	831,000	19,994,000	54,600
1933	344,268,000	943,200	323,705,000	886,900	20,563,000	56,300
1934	368,976,000	1,010,900	340,371,000	932,500	28,605,000	78,400
1935	395,671,000	1,084,000	366,723,000	1,004,700	28,948,000	79,300
1936	445,524,000	1,217,300	410,641,000	1,122,000	34,883,000	95,300
1937	487,788,000	1,336,400	442,355,000	1,211,900	45,433,000	124,500
1938	456,843,000	1,251,600	409,282,000	1,121,300	47,561,000	130,300
1939	507,966,000	1,391,700	458,461,000	1,256,100	49,505,000	135,600
1940	536,263,000	1,465,200	501,014,000	1,368,900	35,249,000	96,300
1941	587,285,000	1,609,000	556,246,000	1,524,000	31,039,000	85,000
1942	625,028,000	1,712,400	591,358,000	1,620,200	33,670,000	92,200
1943	714,969,000	1,958,800	675,118,000	1,849,600	39,851,000	109,200
1944	777,367,000	2,124,000	721,340,000	1,970,900	56,027,000	153,100
1945	794,672,000	2,177,200	749,507,000	2,053,500	45,165,000	123,700
1946	761,508,000	2,086,600	722,923,000	1,980,600	38,675,000	106,000
1947	857,283,000	2,348,700	816,783,000	2,237,800	40,500,000	110,900
1948	875,423,000	2,391,900	841,119,000	2,298,100	34,304,000	93,700
1949	850,235,000	2,329,400	825,299,000	2,261,100	24,936,000	68,300
1950	976,447,000	2,675,200	947,641,000	2,596,200	28,806,000	79,000
1951	1,053,107,000	2,912,400	1,009,963,000	2,767,000	53,054,000	145,400
1952 Est.	1,101,000,000	3,008,200	1,063,000,000	2,904,400	38,000,000	103,800

Source: U. S. Bureau of Mines, except November and December, 1951, estimated with aid of A.P.I. reports.

was the case in 1951, the peak month was August, which saw motoring at its highest demand—3,420,000 barrels daily.

Also following normal seasonal patterns was demand for the light distillate oils. As in 1951, the peak month for distillate fuel use was December, when 1,922,000 barrels were required each day. The low period of both years was June, and 852,000 barrels were used daily in the more recent period. As it was with motor fuel, demand for distillate fuels was greater in each month of 1952 than it had been a year earlier.



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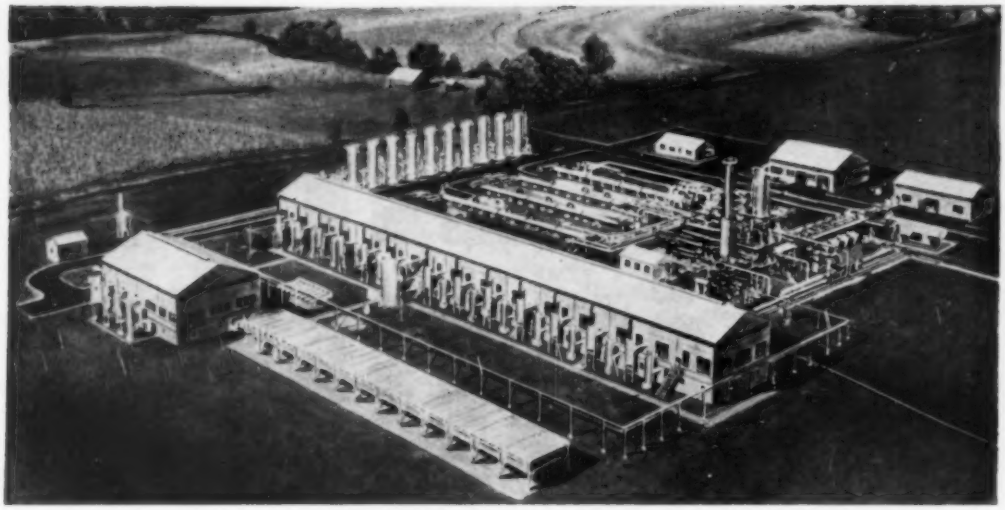


General view of liquid hydrocarbon extraction plant of the Tennessee Gas Transmission Company near Greensburg, Ky.

Tennessee Gas Begins Operation Of Refrigerated Extraction Plant

J. J. KING and R. V. MERTZ

Tennessee Gas Transmission Company, Houston

THE LARGEST gas capacity ever designed for a plant processing natural gas is incorporated in a plant recently completed and put into operation by Tennessee Gas Transmission Company near Greensburg, Ky. The plant receives natural gas from the company's pipe line, removes ethane and heavier hydrocarbons and returns the stripped gas to the pipe line. The design capacity of the plant is 750,000 Mcf per day. Separation of the ethane and heavier hydrocarbons from the gas stream is accomplished by using refrigeration only. Refrigeration capacity required is equivalent to a 12,000 ton-per-day ice making plant.

Mr. King is vice president and Mr. Mertz is compressor superintendent of TGT.

UNDER normal operating conditions the entire gas stream through the Tennessee Gas Transmission Company plant near Greensburg, Ky., will be chilled to minus 96° F. Liquids previously found to be objectionable to gas customers will be condensed and delivered to a chemical company which will separate them into LPG, natural gasoline and ethane. Total liquid production will eventually amount to 380,000 gallons per day when the operation has been stabilized and the design quantity of gas is processed.

A unique heat exchanger arrangement is used in order to accommodate the large volume of gas processed. The gas stream from the pipe line is split into four parallel streams through the plant. Heat exchangers 42 inches in diameter are assembled end to end to form the four heat exchanger trains. The long exchanger train arrangement was chosen to simplify the piping and to provide a straight-through path for the gas. This arrangement makes for low pressure drop in addition to the simplified piping arrangement.

Construction of the plant was started in May, 1950. The site near Greensburg, Ky., was chosen because of the convenience to Tennessee's main transmission line and the chemical plant which will process the extracted liquid stream. Tennessee's extraction plant is connected with the chemical plant by a 60-mile long, eight-inch pipe line.

Plant Processing

The process utilized to recover the hydrocarbons from the pipe line gas consists basically of two major operations. The first operation is the separation of the desired hydrocarbons from the feed gas stream. This is accomplished by cooling the gas stream until a sufficient quantity of the hydrocarbons condense. The second operation involves processing the condensed hydrocarbon liquid to remove unwanted methane and to control the amount of ethane present in the product stream. This is accomplished by flashing the hydrocarbon liquid twice at successively lower pressures and then fractionating it.

The complete process, materials balance, and operating conditions are

shown in the accompanying chart and tables.

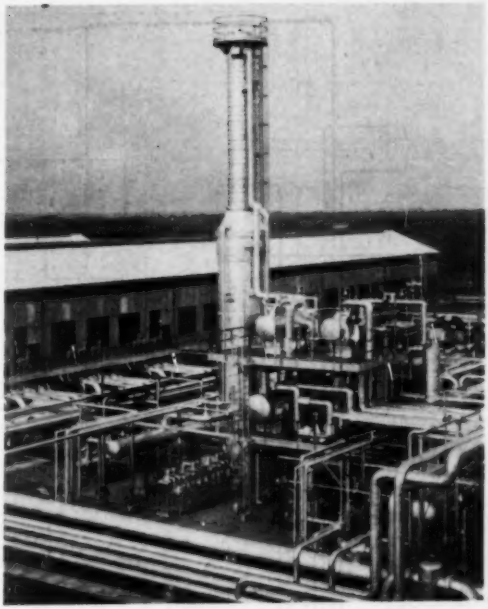
Gas entering the plant from the pipe line must be dried before being subjected to low temperature processing. Ten dehydrators are provided in order to have eight effective units on stream at all times. Each dehydrator contains a 20-foot deep bed of alumina granules through which the wet gas passes during the drying cycle. Water absorbed during this cycle is removed by taking each dehydrator off stream periodically and passing hot gas through the alumina bed. The reactivated dehydrator is then cooled by passing a cool gas stream through the bed and is ready for return to service.

Dry gas from the dehydrators at 70° F. is cooled to —104° F. at approximately 535 psi gage. Under these conditions about 5.5 mol percent of the gas condenses. The condensed hydrocarbon liquid is separated and the residual gas, after heat exchange, is compressed to 590 psi gage and returned to the pipe line.

Four parallel trains of heat exchangers are required for feed gas cooling when the plant is operating at design capacity. Dehydrator exit piping is manifolded in such a way that each exchanger train receives gas from one pair of on-stream dehydrators. Thus, the gas flow through each train is controlled by the setting of the flow controllers upstream of the dehydrators.

In each train these exchangers are bolted end to end, providing straight-through flow for the feed gas on the tube side. The first four shells exchange heat between the incoming warm feed gas and the cold residue gas stream from which the condensed hydrocarbon liquid has been removed. Thus, these exchangers serve the dual purpose of cooling the feed and recovering refrigeration from the residue gas. The fifth shell in each train employs ethane refrigerant at —96° F. to furnish the net refrigerating effect required to remove latent heat from the liquid product. The last shell in line recovers refrigeration by evaporating excess light hydrocarbons, principally methane, which were condensed in the high pressure separator.

The hydrocarbon liquid collected in the liquid separator is flashed to a lower pressure. In passing through the expansion valve, a portion of the liquid is vaporized and the stream is cooled by self-refrigeration. The vapor-liquid stream is warmed by heat exchange with the feed, the liquid is separated and flows to the second feed flash operation while the disengaged vapor, after further heat exchange, is compressed and returned to the pipe line.



Refrigeration Area with De-Ethanizer Tower in Center and Compressor Building in Background.

This series of operations, constituting the first feed flash, is designed to reduce the methane content of the hydrocarbon liquid condensed from the feed gas. The liquid is flashed and heated under conditions which are favorable to the preferential vaporization of methane and which also make possible the recovery of valuable low temperature refrigeration.

Liquid from the first flash exchanger is flashed to a lower pressure. The residual liquid from the flash is separated from the vapor and is forwarded to the fractionator, while the vapor, after heat exchange, is used for plant fuel. While the first flash operation removed a substantial amount of methane from the liquid stream, a further reduction in methane content is necessary.

In the second flash, a methane-rich vapor is removed, leaving a liquid of less than half the original methane content. In principle, the second flash operation is quite similar to the first, but differs in that the addition of heat is not required to secure the desired degree of vaporization.

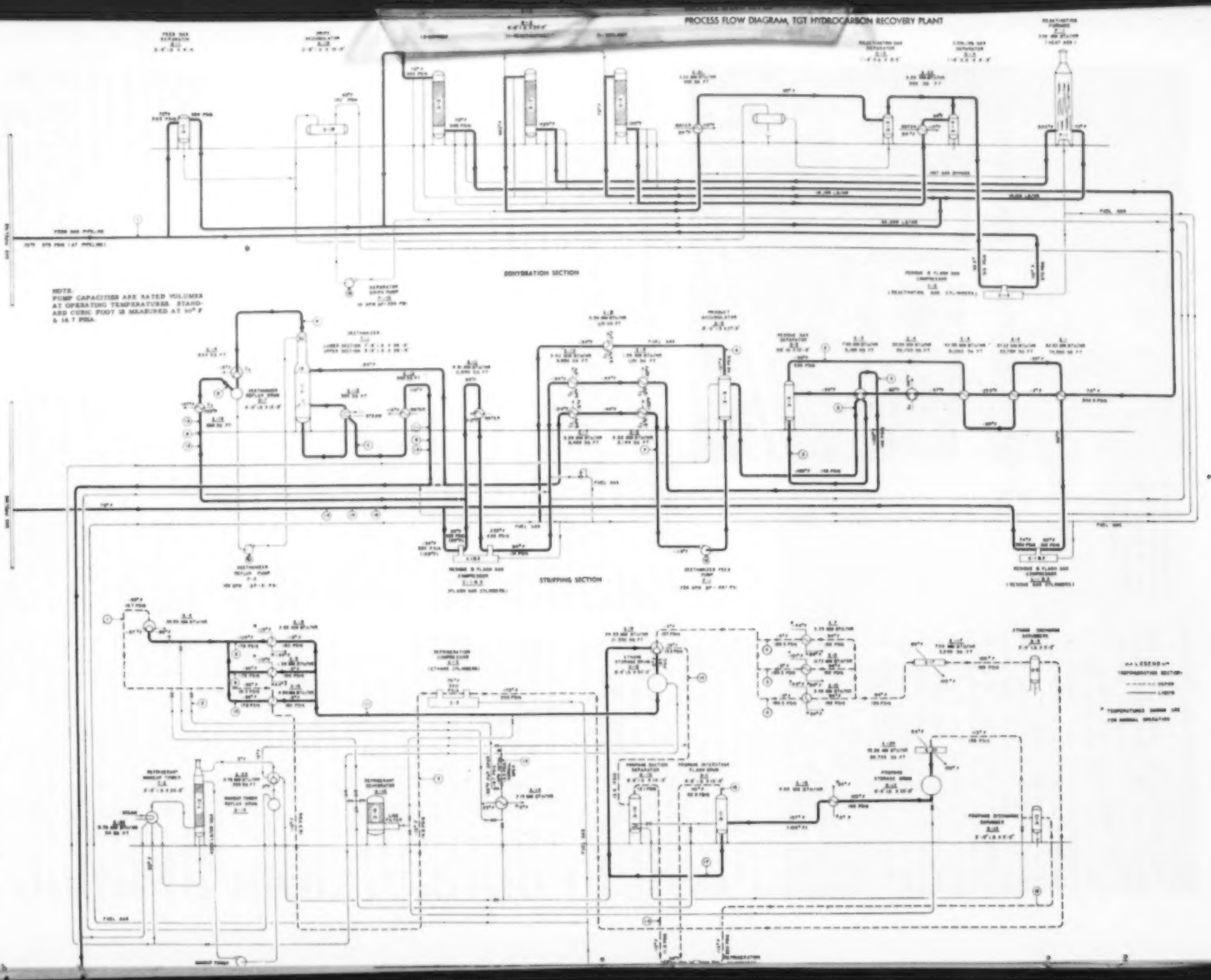
In the second flash operation, first flash liquid at —112° F. and 145 psi gage flows into a common product accumulator which is operated at 40 psi gage. In passing through the level control valve the pressure is reduced from 145 psi gage to 40 psi gage, about 15 mol percent of the liquid is vaporized and the stream self-refrigerates to —121° F.

The —121° F. vapor-liquid mixture is separated in a product accumulator. The liquid is then pumped to the de-ethanizer, while the —121° F. vapor is warmed to 84° F. by heat exchange with an ethane refrigerant stream and then flows into the plant fuel system.

Liquid from the product accumulator is pumped through heat exchanges to the de-ethanizer. The tower produces a bottoms liquid product of desired specifications which is cooled and then flows from the plant to the product line. Tower overhead vapor, after heat exchange, is compressed for return to the gas pipe line.

Process Gas Compression

The residue gas stream, the first flash vapor stream and the de-ethanizer overhead must be compressed for return to the pipe line. In addition, the dehydrator reactivating and cooling gas requires recompressing in order to get it back into the feed gas to the plant. Six 1760-hp. gas engine-driven reciprocating compressors are used for process gas compression. Each of these machines is multi-purpose in that it is designed to handle more than one of the services mentioned above. Four of the machines are each equipped with four compression cylinders. Two of these cylinders are designed for residue gas service, while the remaining two handle the first and second stage flash gas services respectively. The other two machines also have four compressor cyl-


PROCESS FLOW DIAGRAM, TGT HYDROCARBON RECOVERY PLANT
DEHYDRATION SECTION
STRIPPING SECTION
NOTE:
PUMP CAPACITIES ARE RATED VOLUMES AT OPERATING TEMPERATURES. STANDARD CUBIC FOOT @ MEASURED AT 60° F & 14.7 PSIA.

Process Materials Balance

Stream No.	(1)		(2)		(3)		(4)		(5)		(6)		(7)		NORMAL OPERATION (8)		NORMAL OPERATION (9)		FUTURE OPERATION (10)		FUTURE OPERATION (11)	
Description	Feed Gas		Residue Gas		Separator Liquid		1st Flash Vapor		1st Flash Liquid		2nd Flash Vapor		2nd Flash Liquid		Deethanizer Ovhd.		Deethanizer Btms.		Deethanizer Ovhd.		Deethanizer Btms.	
Component	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.
Carbon Dioxide	288.2	12,683	247.9	10,910	40.3	1,773	24.7	1,087	15.6	686	4.1	180	11.5	506	9.2	405	2.3	101	5.7	250	5.8	256
Nitrogen	346.0	9,695	339.4	9,510	6.6	185	6.6	185	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Methane	77,359.0	1,240,839	74,565.9	1,196,037	2,793.1	44,802	2,407.6	38,618	385.5	6,184	242.2	3,885	143.3	2,299	129.8	2,083	13.5	216	123.3	1,978	20.0	321
Ethane	2,998.0	90,150	2,268.4	68,211	729.6	21,939	191.1	5,746	538.5	16,193	31.3	941	507.2	15,252	128.2	3,860	379.0	11,392	11.0	331	496.2	14,921
Propane	831.9	36,670	359.1	15,829	472.8	20,841	16.5	727	456.3	20,114	2.5	110	453.8	20,004	.....	.....	453.8	20,004	.....	.....	453.8	20,004
Iso-Butane	148.2	8,612	39.5	2,295	108.7	6,317	1.6	93	107.1	6,224	.....	.....	107.1	6,224	.....	.....	107.1	6,224	.....	.....	107.1	6,224
n-Butane	197.7	11,488	29.7	1,726	168.0	9,762	0.8	46	167.2	9,716	.....	.....	167.2	9,716	.....	.....	167.2	9,716	.....	.....	167.2	9,716
Pentanes	90.6	6,536	3.3	238	87.3	6,298	.....	.....	87.3	6,298	.....	.....	87.3	6,298	.....	.....	87.3	6,298	.....	.....	87.3	6,298
Hexanes	74.1	6,384	1.2	103	72.9	6,281	.....	.....	72.9	6,281	.....	.....	72.9	6,281	.....	.....	72.9	6,281	.....	.....	72.9	6,281
Heptanes Plus	32.9	3,553	0.4	43	32.5	3,510	.....	.....	32.5	3,510	.....	.....	32.5	3,510	.....	.....	32.5	3,510	.....	.....	32.5	3,510
Total Stream	82,366.5	1,426,610	77,854.8	1,304,902	4,511.8	121,708	2,648.9	46,502	1,962.9	75,206	280.1	5,116	1,582.8	70,080	267.2	6,348	1,315.6	63,742	160.0	2,559	1,442.8	67,531
Gas Volume, MSCF/Hr.	31,250		29,500.0				1,004.0				106.2				101.2				53.0			
Liquid Volume, GPM at 60° F.					580.0				307.5				378.0				244.0				264.0	

Process Materials Balance—Continued

Stream No.	INITIAL OPERATION (12)		INITIAL OPERATION (13)		(14)		(15)		(16)	
					GAS RETURNED TO PIPE LINE					
Description	Deethanizer Ovhd.		Deethanizer Btms.		Initial		Normal		Future	
Component	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.
Carbon Dioxide	11.1	489	0.4	17	281.2	12,375	279.3	12,291	275.8	12,136
Nitrogen	.....	.....	.....	.....	345.3	9,676	345.3	9,676	345.3	9,676
Methane	143.3	2,299	.....	.....	76,870.6	1,233,004	76,857.1	1,232,788	76,850.6	1,232,683
Ethane	494.2	14,572	23.0	680	2,924.1	—87,942	2,568.1	77,220	2,450.9	73,701
Propane	19.7	847	434.1	19,157	393.6	17,329	373.9	16,482	363.9	16,482
Iso-Butane	0.8	44	106.3	6,180	31.7	2,421	40.9	2,377	40.9	2,377
n-Butane	.....	.....	167.2	9,716	30.4	1,766	30.4	1,766	30.4	1,766
Pentanes	.....	.....	87.3	6,298	3.3	238	3.3	238	3.3	238
Hexanes	.....	.....	72.9	6,281	1.2	103	1.2	103	1.2	103
Heptanes Plus	.....	.....	32.5	3,510	0.4	43	0.4	43	0.4	43
Total Stream	659.1	18,251	923.7	51,839	80,881.8	1,364,897	80,499.9	1,352,994	80,362.7	1,349,205
Gas Volume, MSCF/Hr.	250.0				30,620		30,550		30,420	
Liquid Volume, GPM at 60° F.			181.3							

Deethanizer Operating Conditions

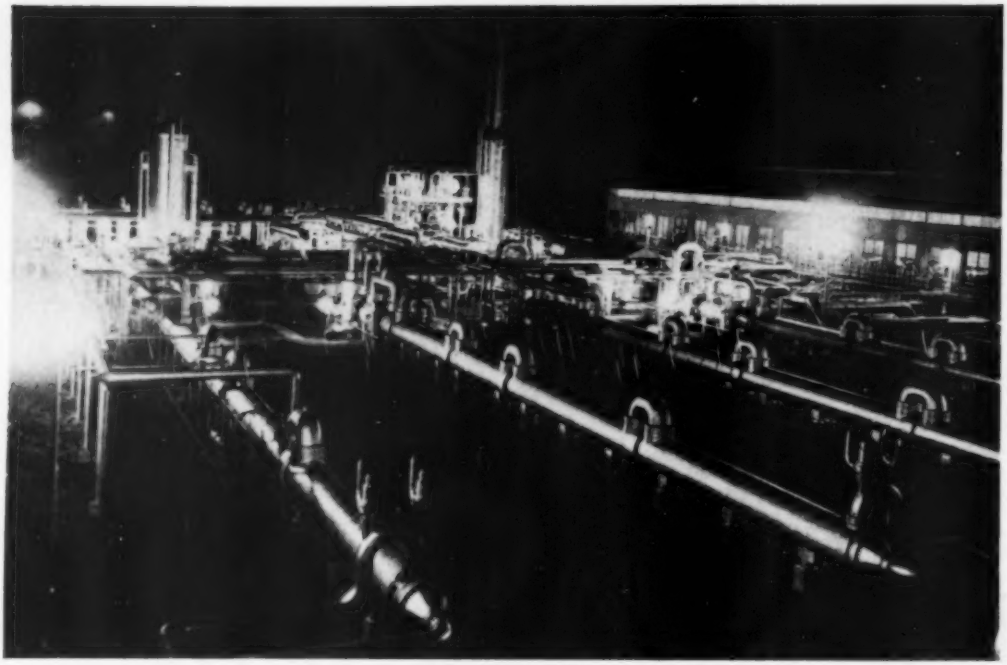
	INITIAL OPER.	NORMAL OPER.	FUTURE OPER.
A Tower Top	39° F. & 451 Psig.	25° F. & 486 Psig.	—42° F. & 451 Psig.
B Net Overhead	34° F. & 450 Psig.	0° F. & 485 Psig.	—85° F. & 450 Psig.
C Net Bottoms	230° F. & 455 Psig.	150° F. & 490 Psig.	130° F. & 455 Psig.

	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.	Mol./Hr.	Lb./Hr.
Gross Overhead	1,264.1	36,915	667.2	17,663	259.0	5,518
Reflux	605.0	18,664	400.0	11,315	119.0	2,959

	MM. BTU./Hr.	MM. BTU./Hr.	MM. BTU./Hr.
E-12 Duty	3.74 ⟶	1.53 ⟶	0.81 ⟶
E-13 Duty	8.76 ⟶	4.15 ⟶	2.49 ⟶
E-14 Duty	2.13 ⟶	1.25 ⟶	0.55 ⟶
E-16 Duty	0.80 ⟶	0.36 ⟶	0.28 ⟶

Refrigeration System Materials Balance

Stream No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
INITIAL OPERATION																	
Lbs./Hr.	160,010	.....	160,010	91,650	9,560	58,800	.....	42,240	25,240	92,530	160,010	165,750	14,750	180,500	239,900	59,400	180,500
SCFM	33,630	.....	33,630	19,280	2,010	12,340	.....	.....	.....	.....	.....	23,750	2,110	25,850	34,350	8,500	.....
GPM at 60° F.	.....	.....	.....	.....	.....	.....	.....	226	135	496	860	.....	.....	.....	.....	.....	705
NORMAL OPERATION																	
Lbs./Hr.	160,010	.....	160,010	91,650	9,560	58,800	.....	42,240	25,240	92,530	163,019	165,450	8,650	174,100	232,960	58,860	174,100
SCFM	33,630	.....	33,630	19,280	2,010	12,340	.....	.....	.....	.....	.....	23,670	1,240	24,910	33,310	8,410	.....
GPM at 60° F.	.....	.....	.....	.....	.....	.....	.....	226	135	496	857	.....	.....	.....	.....	.....	681
FUTURE OPERATION																	
Lbs./Hr.	160,010	2,540	162,550	92,950	9,800	59,800	.....	42,990	25,700	93,980	162,850	160,800	.....	160,800	227,900	58,100	160,800
SCFM	33,630	535	34,165	19,535	2,060	12,570	.....	.....	.....	.....	.....	34,250	.....	34,250	32,560	8,310	.....
GPM at 60° F.	.....	.....	.....	.....	.....	.....	.....	230	138	503	871	.....	.....	.....	.....	.....	664



Night View of TGT's Greensburg Plant with Feed Gas Exchangers in Foreground and De-Ethanizer in Center Background.

inders each. In the latter case the first two cylinders are designed for residue gas compression, the third for first stage flash gas and the fourth for reactivating gas.

The speed of each of the compressors is controlled from a common source to maintain the desired plant feed gas rate. The speed control governor on each of the machines is actuated by differential pressure controller. This instrument maintains a fixed pressure drop in the feed gas stream across the feed gas flow controllers and dehydrators by controlling the rate at which residue gas is withdrawn from the process.

In order to obtain the desired compression characteristics for the flash gas and reactivating gas services, clearance pockets are provided in all compressor cylinders. These clearance pockets must be manually adjusted to balance compression loads between the three services and insure the desired compression ratio and capacity for each service.

Refrigeration

A conventional ethane-propane cascade-type refrigeration system is employed to provide low level ethane refrigeration at —96° F. and intermediate level propane refrigeration at —15° F. Ethane refrigerant is circulated in a closed system and condensed with propane refrigerant which also circulates in a closed system, and, in turn, is condensed with cooling water.

In the ethane refrigeration cycle, liquid ethane flows to the feed gas coolers (and to the de-ethanizer condensers). Exchangers utilize refrigeration available in low temperature process streams to cool the liquid refrigerant and to reduce the amount of liquid required for a given refrigeration load.

The ethane is vaporized at 19.7 psi gage and —96° F. in the feed gas coolers and the vapor flows through an exchanger to the compressor suction. The ethane liquid-vapor exchanger serves a dual purpose in that it recovers valuable refrigeration from the low temperature vapor stream and at the same time warms the vapor sufficiently to permit safe operation of the first stage compressor cylinders. By warming the vapor to —15° F. any entrained liquid droplets will be vaporized before entering the compressor. Low temperature alarms are provided in the ethane compressor suction line. These alarms flash warning signal lights in the control house and compressor house if the vapor temperature drops to —25° F. and automatically shut down the compressors if the temperature drops to —50° F.

The ethane vapor is compressed through two stages from 14.8 psi gage to 200 psi gage. Suction pressure is held constant by controlling the compressor speed through the action of a pressure controller. Compressed vapor is aftercooled to 94° F. and partially condensed in exchangers. These exchangers utilize refrigeration available in low temperature process streams to reduce the load on the propane-cooled ethane condensers. Partially condensed ethane is totally condensed at —5° F. in the main ethane condensers and returned to the storage tank thus completing the ethane refrigeration cycle.

In the propane refrigeration cycle, liquid propane flows into the interstage flash drum. As the liquid enters this drum, under level control, its pressure is reduced from about 190 psi gage to 63 psi gage, a portion of the liquid is vaporized and the stream is self-refrigerated to 40° F. The refrigeration effect of interstage flash operation improves the efficiency of the propane refrigeration system by reducing the amount of propane which must be circulated through the low pressure side of the system for a given refrigeration load.

Vapor from the interstage flash drum is taken directly into the second stage suction of the propane compressors.

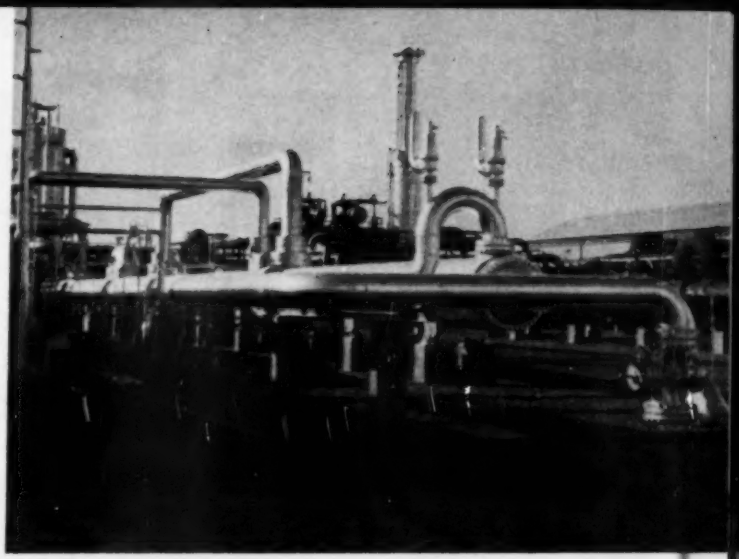
In order to avoid the possibility of liquid carry-over into the compressors, the flash drum is provided with a metal mesh separator element which will remove entrained droplets and with high level alarm controllers which guard against liquid overflow. These instruments actuate signal lights in the control room and compressor house if the liquid level rises above normal operating limits and shut down the compressors if the level continues to rise.

Propane liquid from the interstage flash drum flows into the shell side of ethane condensers, the de-ethanizer condenser, and the make-up tower condenser. Individual level controllers mounted on the shell of each of these exchangers govern the rate at which the propane is admitted. Propane vaporized in these units at —15° F. and 13.3 psi gage flows through the propane suction separator into the low stage compressor cylinders. The separator drum is sized to remove entrained liquid droplets from the vapor stream and contains a heating coil to vaporize any liquid collected. Hot propane vapor from the compressor second stage discharge is used as the heating medium in this coil. High level alarm controllers actuate signal lights in the control and compressor houses if the liquid level rises to a predetermined point and shut down the refrigerant compressors if the separator liquid level continues to rise.

Propane vapor from the suction separator is compressed from 11.8 psi gage to 60.9 psi gage in the first stage compressor cylinders. Vapor from the interstage flash drum joins this stream in the interstage header and the combined streams are compressed to 200 psi gage in the second stage. The high pressure vapor is totally condensed in water cooled propane condensers and then flows into the propane storage drum, thus completing the propane refrigeration cycle.

Seven identical 1760-hp. reciprocating compressors are provided for refrigerant service. Each machine is equipped with four compressor cylinders, two of which handle the first and second stage propane service while the other two are designed for first and second stage ethane compression. As mentioned previously, compressor speed is automatically varied to maintain a constant ethane suction pressure. In order to balance ethane and propane compression loads and to secure the desired propane suction conditions, clearance pockets are provided on all compressor cylinders.

Separators are provided downstream of the compressors in both the ethane and propane systems. These units are designed to remove lube oil which the refrigerant streams may pick up in passing through the compressor cylinders.



Feed Gas Heat Exchanger Battery Viewed from Warm End.

A refrigerant dehydrator is provided for the common use of the two refrigeration systems. This unit contains alumina desiccant for adsorbing water from the refrigerants and incorporates all necessary equipment and controls for reactivating the desiccant and disposing of the adsorbed water.

Refrigerant Makeup

Facilities have been incorporated in the plant to produce substantially pure ethane and propane for the refrigeration systems. It is estimated that approximately 1 lb. per bhp per month of refrigerant will be required to makeup for system losses. On this basis the quantity of ethane required as makeup per month will be about 1500 gallons and the quantity of propane about 1000 gallons.

When the plant is in normal operation the refrigerant makeup tower is operated periodically as a batch still to produce ethane and propane makeup for the refrigeration systems. The tower is 24 inches in diameter and contains 15 feet of Berl saddles as packing. It is equipped with a steam-heated reboiler and a propane-refrigerated reflux condenser. A differential pressure controller maintains a constant pressure drop across the packed section to prevent flooding by acting in conjunction with a flow controller to control reboiler heat input. Feed for the makeup tower is taken either from the deethanizer reflux or bottom product. It is obtained from the de-ethanizer reflux when ethane is to be made and from the bottom product when propane is to be made.

Fire Protection

The fire protection system consists of two Underwriters-approved fire pumps taking suction from the storage tank gravity feed line and discharging to an underground grid system of piping with hydrants and small hose cabinets at strategic locations in the process and residence areas.

Each fire pump is rated at 500 gpm with a discharge head of 100 psi gage. One pump is electric motor drive and one gasoline engine drive. Both pumps are manually operated from the water treating building and the grid system is under pressure only when the pumps are in operation.

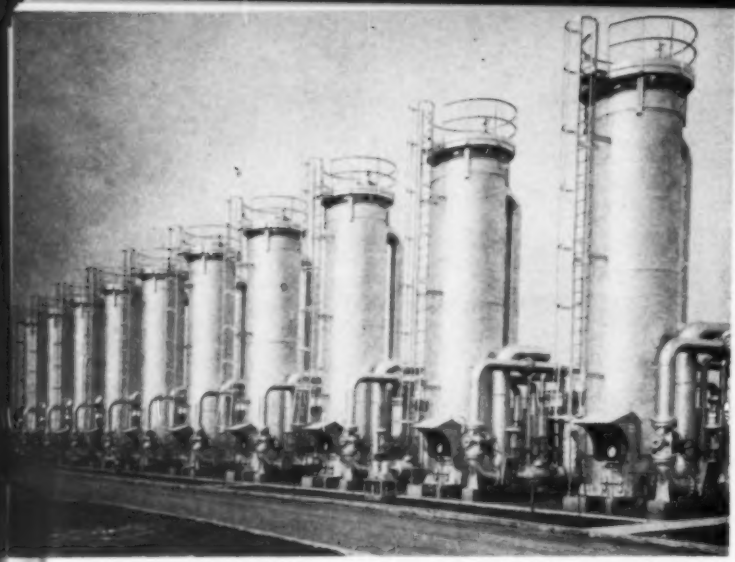
Steam and Condensate

Steam is supplied by a package type steam generating unit. This unit consists of boiler, combustion equipment, mechanical forced draft, and boiler feed water return system complete with necessary fittings and controls. The natural gas fired, water tube type boiler has a rated capacity of 12,000 pounds per hour of steam from and at at 212° F. Its maximum pressure rating is 160 psi gage but it will normally operate at or below 100 psi gage.

Condensate is returned under steam pressure from the steam traps to the vented condensate receiver and is pumped into the boiler by the boiler feed pumps. Treated water is used for boiler feed makeup.

Fuel Gas

Process vent gas streams constitute the normal source of plant fuel. The



This row of ten solid-type dehydration towers reduces the dew-point of the main gas stream to about —100° F.

compressor fuel system operates at 25 psi gage and receives most of its fuel from the second flash vapor stream. However, this stream is insufficient to meet the total compressor fuel demand, so a small portion of the first flash vapor stream is used to make up the deficit. A pressure controller allows enough of the 135 psi gage first flash vapor to bleed into the compressor fuel system to maintain the desired 25 psi gage pressure in that system.

The auxiliary system normally receives all its fuel from the first flash vapor stream. The 135 psi gage gas is taken from the flash vapor compressors' first stage suction header, throttled through a pressure controller and distributed through the system at 25 psi gage.

Water Supply and Treatment

Water is drawn from the Green River through twin intake caissons and is pumped to a 300,000 gallons capacity storage tank near the plant site by means of two vertical turbine type deep well pumps.

Each pump has a capacity of 200 gpm at a discharge pressure of 140 psi gage. One pump has an electric motor drive, the other a combination electric motor and gasoline engine drive with disengaging clutch. It is intended that one pump will carry the normal load although the pumps may be run in parallel if required. Pump operation on electric motors is by means of an altitude controller actuated by the head of water in the tank. The gasoline pump, for use when electric power is not available, is manually controlled.

From the storage tank water flows by gravity to the water treating building where it is treated for boiler makeup, jacket cooling and building service.

The water treating plant is designed for a continuous rated net output of 30 gpm with capacity to handle 60 gpm when all filter and softener units are in operation. The water treatment consists of the following steps: 1) Coagulant feed, 2) filtration, 3) sodium zeolite softening, and 4) hypochlorination.

The water to be treated is first pumped to an elevated storage tank from which it flows by gravity to the inlet lines of two 4½-foot diameter lined sand and gravel pressure filters for removal of suspended material. The pressure filters are arranged to operate in parallel with all operations associated with backwashing controlled by a multiport valve.

As an aid to filtration, a coagulant is fed in the form of a preformed alum floc. The floc is prepared in a 2½-foot diameter lined tank provided with motor-driven agitator for effective mixing and is then delivered to the filter units.

Following filtration the water is next pumped to the influent lines of two 2½-foot diameter lined softener units where calcium and magnesium hardness is removed by ion exchange. The softeners are arranged to operate in parallel with all operations associated with backwashing and regeneration controlled by a multiport valve.

To provide a bacterially-safe water for building service, hypochlorite solution is delivered in proportion to flow into the softened water header to maintain a chlorine residual of approximately 0.2 ppm to 0.5 ppm leaving the service water tank.

Cooling Water

A two-cell, induced draft, coil shed-type cooling tower is utilized to cool about 6000 gpm of water from 102° F. to 84° F. under design conditions. The major portion of the cooled water is passed over atmospheric cooling sections located within the tower structure, collected in a sump and recirculated to the top of the tower. The remainder of the cooled water is collected in a separate sump, pumped through the plant cooling water circuit and returned to the top of the tower.

Raw water from the water storage tank is utilized for makeup. Sulfuric acid and chlorine are metered into the cooling water system at different points to precipitate solids and inhibit algae growth respectively. A continuous blowdown of approximately 25 gpm is maintained to prevent solids build-up in the system.

Jacket Water

Cooling water is circulated in a closed system through engine jackets, lube oil coolers and the first stage flash gas and propane compressor cylinder jackets. All other compressor cylinder jackets are individually equipped with thermal siphon cooling systems which are filled with ethylene glycol solution.

Approximately 10,800 gpm of water at 160° F. is circulated by the jacket water pumps. Of this total, 3195 gpm is cooled to 120° F. in air-cooled exchangers and then flows through the lube oil coolers. Water leaving the lube oil coolers at 126° F. is blended with the balance of the 160° F. water from the jacket water pump discharge to give about 10,800 gpm of 150° F. water for engine and compressor cylinder jacket cooling. This water returns to the engine jacket water surge tank at 160° F. for recirculation through the system.

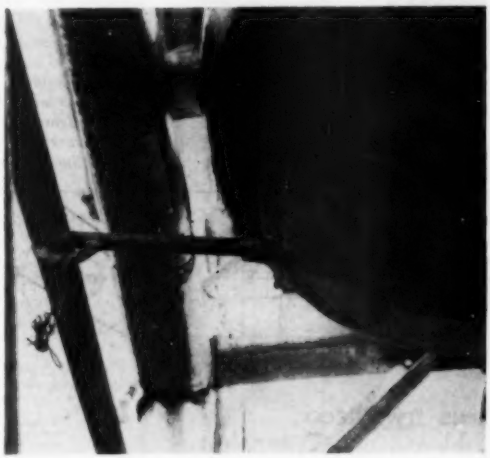
The jacket water system is provided with controls which will automatically maintain proper flow quantities and temperature levels. A temperature controller maintains a constant temperature of 150° F. in the blended stream to the engine jackets by controlling the amount of 160° F. water which enters the stream. Another temperature controller insures that the temperature of the lube oil cooler stream does not drop below 120° F. by adding 160° F. water, as required.

The plant was designed and constructed by Stone and Webster Engineering Corporation of Boston.

MAINTENANCE And OPERATION How To Do It—

Removing Manhole Covers

DIFFICULTY in removing hard-to-get-at manhole covers was solved by one plant operator on a vessel equipped with a bottom head manhole. To solve the problem, a triangular piece of steel was welded to the head so an adequate handle might be bolted to the cover. When unbolting the cover, a heavy weight is attached to the outer end of the handle to secure the cover. When the cover is replaced, this weight serves to press the cover against the flange while the bolts are inserted and tightened.



Mechanical Stirrer for Mixing Paint

MIXING paints in small quantities has been mechanized by one painter through the use of a conventional hand drill fitted with a paddle. The paddle was fabricated from a convenient length of half-inch rod and a rectangular piece of steel. The rod is slotted to fit this piece; and after being welded in place, the bottom portion of the paddle is ground smoothly to avoid cutting the bottom of the paint can when in use.

Insulation Protection

BECAUSE no insulating material can withstand repeated mechanical abuse, special protection should be provided at points where insulation may be subjected to more than ordinary wear and tear.

Due to the layout of lines or equipment, as when lines are located at floor level near stairways, ramps or platforms, it may be impossible to prevent battering of insulated surfaces. Sometimes chains hanging from overhead chain hoists strike repeatedly against insulated lines or equipment.

Insulation that is exposed to such mechanical abuse may be protected by means of a sheet metal jacket which will cover the entire area of possible damage. The jacket may be tack-welded, or held in place with screws or bolts.

Where required, expansion joints with spring-loaded bolts may be provided in the jacket to compensate for circumferential expansion.

MAINTENANCE And OPERATION
How To Do It–

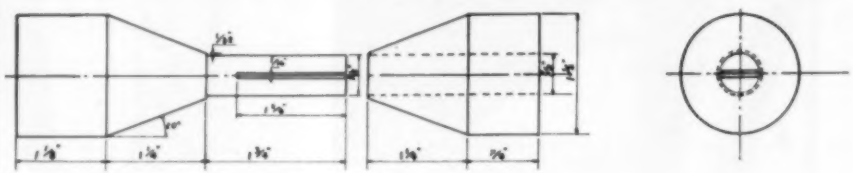
Waste Rag Storage

HAZARDOUS conditions resulting from the use of an ordinary oil drum for storing soiled rags can be materially reduced by the use of this ventilated container. The container may be fabricated by the use of two hoops, which form the top and bottom structure and are connected by vertical straps of iron. To the bottom hoop is soldered a circular piece of hardware cloth, while the top hoop is provided with a hinged lid. The body of the container is covered with hardware cloth, soldered at all seams. The container is supported by three spread legs.

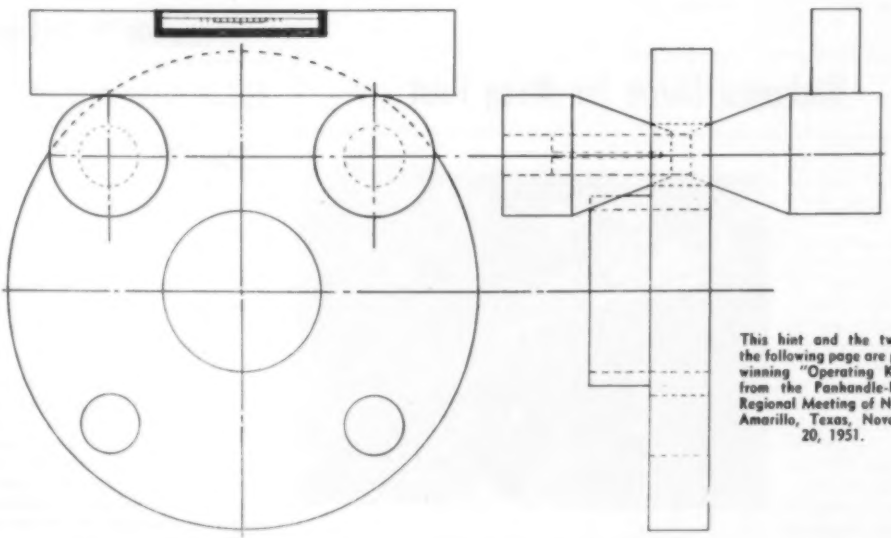
Aligning Welding Flanges

POSITIVE two-hole alignment of standard flanges may be accomplished with the use of the line-up pins shown in the sketch. The line-up pins were made from stainless steel pump shaft. In use, each pin is placed through the two top holes of the flange. As the two pin parts are pushed together snugly, the beveled edges will bind against the front and back of the flange. Placing the level on top of the pins, the flange may be turned to a perfect level. Since the companion welding fitting is now ready to be tacked on the flange, this procedure prevents the necessity of having to double-check the alignment. The savings in time, though difficult to estimate, would be a considerable asset to construction welders.

—Second Prize, Class D, by K. T. Henson and O. L. Watson, Shamrock Oil and Gas Corporation, Sunray, Texas.



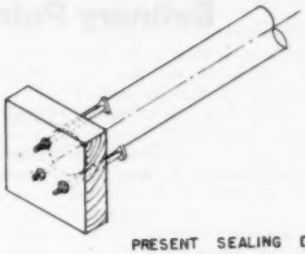
FLANGE ALIGNING PINS TWO REQD.



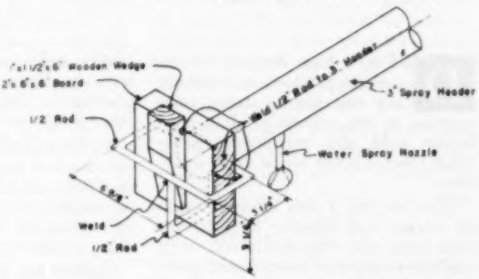
This hint and the two on the following page are prize-winning "Operating Kinks" from the Panhandle-Plains Regional Meeting of NGAA, Amarillo, Texas, November 20, 1951.

Sealing Spray Headers for Easy Cleaning

TO facilitate cleaning spray headers in cooling towers, the conventional sealing device was modified to permit the cleaning job to be done quickly and inexpensively. The conventional sealing devices for the end of spray header piping are screwed caps or wooden blocks bolted to lugs affixed to the header. The modified sealing device consists of a basket receptacle fabricated from ½-inch rod, the box-like receptacle being welded to the end of the header. The receptacle is of sufficient size to contain a square wooden block, approximately 2-inch in thickness, which covers the end of the header.



PRESENT SEALING DEVICE



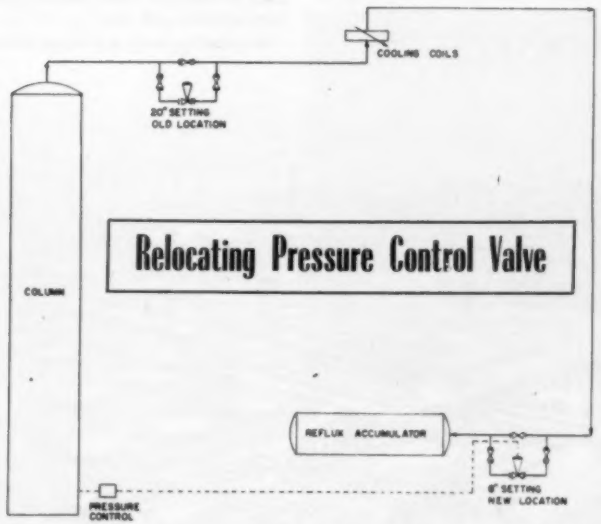
SUGGESTED IMPROVED SEALING DEVICE

The block fits loosely enough in the container to permit a wooden wedge to be inserted. A sharp tap of the wedge forces the block sufficiently tight against the pipe opening to secure a water-tight seal. To remove the block, the wedge is knocked out and the loose block lifted from the housing by hand. No movable metal parts are featured in the device; hence, corrosion is no problem.

—First Prize, Class A, by Jim Barton, Phillips Petroleum Company, Phillips, Texas

Refilling Extinguishers

WHEN fire extinguishers have been exhausted of CO_2, refilling the equipment may be facilitated by use of the pictured apparatus for liquefying CO_2. Three vertical pressure vessels, provided with manholes, are employed as containers for the solid chunks of dry ice. After being filled with dry ice, steam is applied to the vessels to hasten liquefaction. Refilling fire extinguishers from this source eliminates the time lag in shipping the containers to suppliers.



Relocating Pressure Control Valve

IN A distillation column where the pressure was controlled by a back pressure control valve in the overhead vapor line, the relocation of the valve to the outlet side of the condenser effected considerable savings in valve investment and condenser efficiency. As shown in the sketch, the original installation required a 20-inch control valve, while the new location at the condenser outlet required only an 8-inch valve. In addition, the efficiency of the cooling coils increased 10 percent.

—Second Prize, Class B, by H. E. Sullender, Phillips Petroleum Company, Phillips, Texas.

How One Company Handles

Refinery Painting

W. B. COOK
Gulf Oil Corporation
Port Arthur, Texas

ONE OF THE most troublesome problems at every refinery is that of minimizing external corrosion. No one realizes this more than Gulf Coast refiners, such as Gulf Oil at Port Arthur. Gulf has developed a progressive program of corrosion control through systematic refinery painting. As has been stated before, "if you protect the surface, you protect all."

Here the author discusses the many problems of surface protection through painting. Factors to be considered include the nature of the surface to be protected, the character of the exposure expected, and the various paint materials available for protection. This presentation was originally before the South Central Regional Meeting, National Association of Corrosion Engineers, Corpus Christi, Texas, October 17-20, 1951.*

DUE to a high demand for petroleum products at relatively low cost and to strong competition in the refined product marketing field, the petroleum refiner must process crude oil in large quantities.

This requires a vast refinery layout of storage and transfer facilities for both crude and refined products, large and varied types of complicated processing units, power generating plants, maintenance shops, pump houses, warehouses, laboratories, administrative office buildings, fire fighting facilities and equipment for furnishing huge quantities of water for steam generation, condensing, cooling and other purposes.

Surfaces of this physical equipment, composed of various materials of construction, are subject to a wide variety of conditions which dictate a policy of coating the majority of them with paint or other coatings.

Merkle[1] has referred to a petroleum refinery as a vast chemical plant involving all the problems of protection against exposure to high concentrations of moisture, acids, alkalis, petroleum solvents and oils.

In painting work at a large refinery

*Reprinted from *Corrosion*, Volume 8, No. 3, pp. 93-99, March, 1952.

Figure 1. Gulf Oil Corporation Refinery, Port Arthur, Texas.

such as that of Gulf Oil Corporation's plant at Port Arthur, Texas, many problems are encountered, some of which are common to other phases of the oil industry, while others more closely resemble those of the chemical plant. Figure 1 shows a general view of a large portion of this refinery and illustrates the vast expanse of exterior surface area coated with paints.

Because of the solvent properties of the petroleum hydrocarbons processed, their inflammable and explosive characteristics, the chemical attack potentialities of sulfur compounds present in some crudes and some of the partially processed products, the chemical attack and solvent power of refining agents used in processing, extremes of temperature and pressures employed in the refinery operations, and a variety of construction material surfaces involved, several methods of surface preparations must be employed, and a number of different types of coating systems used.

In his article on "Recent Developments in Paints for the Petroleum Industry," Oxley[2] lists a number of reasons, in addition to protection and decorative purposes, as the basis for selection of suitable paints. Chief among these applying to refinery equipment are:

1) Heat reflection to prevent loss of volatile products by evaporation.

2) Prevention of product contamination.

3) Sanitation and good housekeeping.

4) To facilitate the cleaning of equipment.

5) Light reflection for providing good visibility and improving lighting effect.

6) Resistance to abrasion, mildew, heat or flame.

7) Identification.

In addition to these, paints are used in the petroleum refinery for safety markings, directional and employee informative signs, for minimizing the effect of erosion and increasing liquid flow, prevention of iron bacteria growth and for company advertising purposes by way of distinctive markings of company properties.

With the economic viewpoint constantly in mind, and continually guarding against false economy measures, the refinery painting program at Port Arthur is designed to provide the afore-listed properties, as well as maximum protection and good appearance, at minimum costs.[3] To accomplish this, paint systems are selected for field test application on the basis of specific types which are designed by the manufacturer for application to surfaces of certain construction materials and are known theoretically and by laboratory testing to be resistant to specific conditions.

Robertson[4] has classified the various types of coatings according to "family" and has listed the outstanding qualities of each in his article entitled "Classification and Uses of Plastic Coatings." This might very well be used as a guide in the selection of paint coating systems for field application trial to meet specific refinery conditions.

Types of construction material surfaces in this refinery for which suitable paint systems must be recommended include steel, galvanized iron, aluminum, concrete, brick, plaster, transite, wood and insulating media such as magnesia block, foam-glass, and the recently developed calcium silicate block which is rapidly gaining favor as a refinery insulating material.

In the field of painting, as in other lines of endeavor, certain basic principles have been established through years of experience and experimentation in the formulation and application of various types of protective and decorative coatings. It has been established that the different types of surfaces and exposure of these surfaces to varying conditions, require: first, properly prepared surfaces; second, specifically balanced formulations of coating ingredients, and; finally, application and drying conditions that will allow the coating system to cure properly before being exposed to attack by the deteriorating forces it was designed to resist.

The importance of good surface preparation cannot be over-emphasized. Provision of a clean, dry surface, free of corrosive contaminants is just as important as selection of the proper coating system. For no matter how good a paint film is it must adhere completely to the surface for a definite length of time in order to do the job for which it was designed.

Figure 2. Closeup of a Freshly Blasted Portion of New Tank Surface Compared with Adjacent Unblasted Portion Weathered for Six Weeks in Hot Summer.

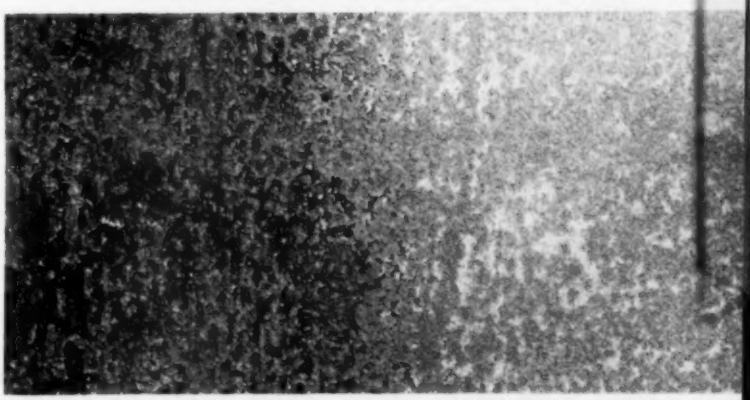
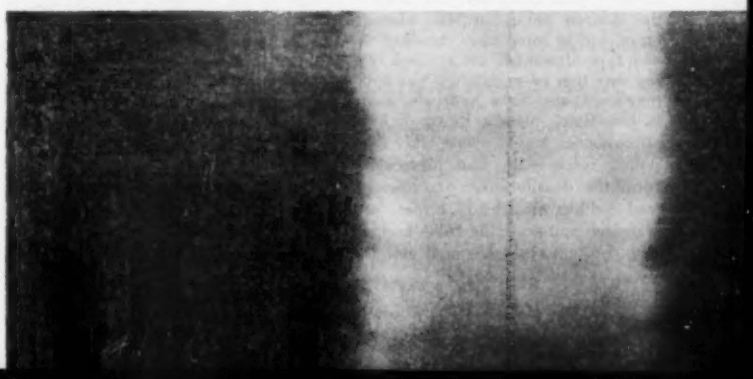


Figure 3. Same Area as Figure 2 from a Distance of About Ten Feet.



MAINTENANCE And OPERATION

How To Do It–

Paints are formulated for application to specific types of surfaces and surface preparations. Therefore, the paint manufacturer recommends types of surface preparation for each system and, to obtain best results, it is advisable to follow these recommendations as closely as possible.

Taking the aforementioned construction materials in reverse order, the insulating materials need little surface preparation other than that they be dry and free of chemical contaminants. Coatings of the bituminous type such as gilsonite-asphalt mixtures or coal tars are applied to these for sealing out moisture. In most applications of insulating materials over steel, it is advisable to thoroughly clean the steel and apply an inhibitive type of primer prior to insulating, because cases of severe corrosion caused by moisture accumulation underneath the insulation have been encountered. Because gloss retention of asphalt and coal tar coatings is not great and because they have a tendency to alligator badly when exposed to sunlight a finish coat of medium oil alkyd black may be applied to provide a gloss black finish and prevent alligatoring. Should a finish color other than black be desired, a seal coat of aluminum paint containing asphalt, or a phenolic aluminum which may also contain some vinyl resin, should be applied to prevent bleeding of the mastic prior to application of a compatible weather coat finish.

Use of Wood Preservative

Wood, used for rough services such as walkways, inside of earthen firewalls, leading to tanks in the storage field, etc., is usually treated only with a wood preservative. Wooden buildings, of which there are few, wooden window frames, etc., are painted according to best domestic practices; that is, a penetrating type of thinned primer is applied to clean, dry, bare surfaces and finish weather coats of the desired color, usually white or ivory, but in some cases standard varnish type aluminum, are applied, making sure that no moisture is entrapped between coats. Since hydrogen sulfide is sometimes present in the refinery atmosphere, and because this compound reacts with lead pigments to form the discoloration products of lead sulfide and lead sulfate, only lead-free paints of the fume and mildew resistant types are used except as primers for steel under some conditions. Mildew, accumulated dirt, discoloration products and contaminants are removed from wooden surfaces prior to painting by scrubbing the surfaces with tri-sodium phosphate solution, flushing with water and allowing adequate drying prior to painting.

Transite is painted only where a decorative effect or light or heat reflection is desired. The use of corrugated transite for building walls and roofs in refineries has gained in favor over the past several years, because its resistance to chemical attack is good. It is not normally painted as its light gray color conforms very well with other exterior paint color schemes. However, where this material is painted for the aforementioned reasons, certain brands of asphalt aluminum paint have been found to offer very good hiding in one coat, whereas when using other types, such as fume resisting medium oil alkyd white, standard varnish type aluminum or alkyd types in other colors, better hiding and adhesion is obtained by first applying a penetrating, thin, base coat such as a flat wall paint, unpigmented aluminum vehicle or the finish coat paint thinned appropriately.

To avoid paint failures on plaster surfaces, careful inspection should be made prior to painting to make sure the plaster is thoroughly free of moisture and that no free alkali is present. Although it is now generally recommended that glue and varnish sizes not be used for sealing purposes, but rather that oil base paint systems designed especially for this type of surface be selected, mildew or chemical reaction discoloration has been encountered which has been successfully sealed on repainting by usage of a varnish-turpentine-alkyd enamel mixture, followed by a coat of fume resistant flat oil paint and a finish coat of a compatible fume and mildew resistant weather coat.

Brick and concrete are porous and must be thoroughly free of moisture prior to painting to avoid blistering when heat draws or drives this moisture to the surface. Whatever paints are used for these surfaces, should have properties conducive to penetrating these pores without bridging over upon drying. Of course, the finish coats should have good resistance to whatever conditions to which they are exposed. Etching of dense concrete, and/or neutralization of free alkali in that freshly finished, with a 10 percent muriatic acid solution, followed by thorough flushing with fresh water and complete drying prior to painting, aids adhesion materially. One difficulty with painted concrete floors in a refinery is damage resulting from the use of kerosine or kerosine-soapy water solutions for clearing. Under certain conditions, this is considered safe practice and the use of this low cost, readily available refinery product affords a glossy sheen to painted floors, but its absorption into the paint film is very detrimental to its adhesion. Thus the use of kerosine for cleaning painted surfaces defeats attempts to improve adhesion by special means.

Use of sheet aluminum has definitely proved this material must be protected with paint in the gulf coast refinery atmosphere. Alkali disintegration from oyster shell dust and salt atmosphere and weak acid attack showed effect within less than two years' time after erection. Etching of this metal with a phosphoric acid solution to provide a good paint bond, priming with a medium oil alkyd vehicle-zinc chromate-iron oxide type of primer and application of a finish coat resistant to the atmospheric conditions have provided very good protection against this damage.

Benefits of Galvanizing

Heavily galvanized iron has given as much as six to eight years' service in the plant without painting before beginning to rust, at which time it has been painted to give many more years of service. Lighter galvanized sheeting has required painting much sooner than this. Galvanized iron in the plant is seldom painted when new, but in the few cases where this is done, the palm oil is either removed by solvent washing or by a short weathering period. Zinc dust primers, formulated especially for galvanized iron, are first applied for affording good adhesion of the paint film. Inhibitive primers containing zinc chromate, lead chromate or red lead are used for rusted galvanized surfaces.

The most widely used refinery construction material is steel and because steel surfaces corrode rapidly and present an unsightly appearance when exposed unprotected to atmospheric and chemical attack, they constitute a large majority of the surfaces coated with paints.

New steel is sand blasted wherever this method of surface preparation is not hazardous due to presence of light hydrocarbon vapors or is not damaging to moving machinery parts. Other methods of steel surface preparation include use of both mechanical and hand powered wire brushes, chipping and knocking hammers, scrapers, etc.; use of steam, chemical solutions, high flash-high solvency solvents as clean-

ing aids and use of metal preparatory solutions such as phosphoric acid and chromate washes.

However, as a consequence of fire and explosion hazards around equipment in which low flash hydrocarbons are handled, non-sparking scraping tools must be used, which, being composed of the softer metals are difficult to keep sharp and naturally do not perform as well as steel tools. Extreme care must be exercised with cleaning agents and metal preparatory solutions because of personnel hazards involved. Continuous operation of refinery equipment, except for widely separated short cleaning and repair periods often prevents employment of the most desirable method of surface preparation prior to painting.

For the sand blast preparation of steel surfaces, Liebman[5] has set definite limits for specific classifications of blast finishes, as shown in Table 1.

These limits might very well be used as standards for sand blasting of refinery equipment steel surfaces. A normal blasting rate on the exterior of new storage tanks has been well established at between 400 and 600 square feet per machine hour, which would be classified near the lower limits of the commercial grade and somewhat better than the sand brush-off. Figure 2 shows a close-up detail of a freshly blasted portion of a 144-foot-diameter by 48-foot-high new tank surface compared with an adjacent unblasted portion which had weathered for about six weeks during hot, summer weather.

These same areas are shown in Figure 3 from a distance of about ten feet. The operating department was crowding the maintenance department to complete the sand blasting of this tank before its being pumped into, because storage space was needed for gas oil production from the stills, so the usual practice of priming the sand blasted portions the same day as blasting is done was not carried out, and blasted portions were allowed to weather from over-night to three days. A thin film of rust formed during this period which was passivated and converted to a harmless phosphate film by spraying the entire surface with a phosphoric metal conditioner solution prior to priming. Figure 4 shows the phosphatized surface together with a treated portion over which fresh primer has just been sprayed. Incidentally, this phosphatized surface was wetted thoroughly by a sudden downpour of rain the day before this photograph was taken but no rust developed as a result. For application of the organic coatings such as vinyls and baking phenolies, the "white surface" class of sand blasting is required but this additional expense is not considered to be justified for ordinary exterior painting work.

On steel equipment in areas subject to hydrogen sulfide fumes, two coats of a medium oil alkyd zinc chromate-iron oxide primer and one finish coat of medium oil alkyd black or gray, or spar varnish type aluminum are used. In relatively chemically clean atmospheres, a prime coat of oil type lead chromate and an intermediate coat of oil type red lead-iron oxide and one finish coat of medium oil alkyd black or gray or spar varnish type aluminum are used. In repaint work, or on new steel where mill scale cannot be entirely removed, only the latter two coats are applied. Sometimes they are preceded by spot priming of badly pitted spots with the aforementioned first coat material.

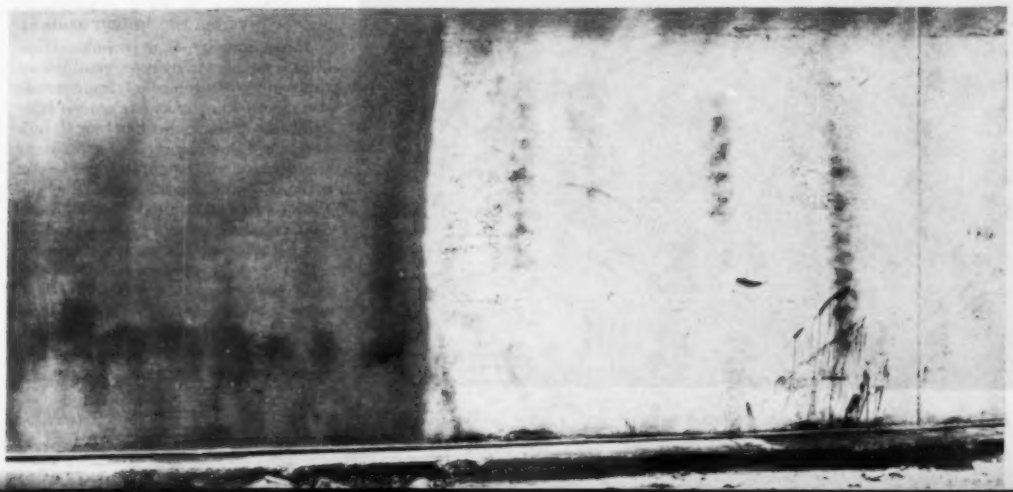
Storage and process unit rundown tanks for high flash point and dark colored oils and all crude tanks have black shells because possible weeping of the dark colored oils on the old-type riveted tanks does not make as bad an appearance on black shells as on those finished in a light color. A standard width upper band of the shell and the roof of these tanks are finished either in aluminum or aluminum colored gray for reflecting heat from the vapor space. Tanks in lighter-than-kerosine service are painted all-aluminum or aluminum colored gray with exception of a black band near the ground level to hide dirt accumulations from rain splashes. The bottom six inches of the exterior of tank shells is coated with a rust preventive amorphous wax type refinery product after the final coat of paint has dried to provide additional protection against moisture at this level.

The surfaces of processing units are painted according to the scheme pre-

TABLE 1

	Sq. Ft. Produced per Machine Hour	Approx. Sand Consumption per Minute	Nozzle Size	Air Pressure
1. White Surface	75– 140	30 Lbs.	$\frac{1}{4}$"	90–95 Lbs.
2. Commercial	275– 400	30 Lbs.	$\frac{5}{16}$"	90–95 Lbs.
3. Sand Brush-Off	650–1000	30 Lbs.	$\frac{7}{16}$"	90–95 Lbs.

Figure 4. Phosphatized Surface over Part of which Primer has been Freshly Sprayed.



viously described for the materials of construction employed. Very little sand blasting can be done due to operational hazards. Finish color schemes for process units are black, aluminum or light gray or a combination of these depending on the nature of the operation. Stairways, walkways, handrails, etc., and the lower exterior portion up to five feet above ground floor level, are painted black for better hiding of dirt and oil deposits.

Chemicals used in the refining processes include sulfuric acid, aluminum chloride, caustic soda, sodium plumbite or litharge solution and copper salts. In manufacturing of aluminum chloride, chlorine is derived from salt brine. Sulfuric acid is recovered from sludge and fortified back to strength in the acid plant operations. These operations, the use of refrigerants, such as ammonia, for refining processes requiring low temperatures, use of large quantities of salt water for cooling and condensing purposes and water treating activities, necessitate the coating of some surfaces with special chemical resistant systems.

Medium oil alkyd and alykd modified chlorinated rubber systems have been found practical, economic coatings for protection against relatively mild acid attack by combined acidic fumes and atmospheric moisture or moisture condensed on surfaces as a consequence of temperature and pressure differentials. Air drying phenolics have shown good resistance to this condition, but the fading characteristic of this type of finish coat when exposed to weather disqualifies it from an appearance standpoint. This deficiency has also been found in chlorinated rubber finishes to a somewhat lesser extent. For the more severe acid attack at the acid and aluminum chloride plants, frequent recoating with low cost coal tar and asphalt paints, where a glossy finish is not important and oil spillage or leakage is not a potential paint dissolving factor, has been found to be economically advantageous.

Chlorinated rubber and alkyd modified chlorinated rubber coating systems have been found to give very good resistance to caustic soda solution spillage. On well weathered rusted tanks, completely free of mill scale and old paint, which are subject to caustic spillage and located in light oil areas where it is too hazardous to sand blast, application of an alkyd red lead primer, followed by careful application of a "flat" chlorinated rubber barrier coat and two vinyl finish coats, very carefully applied to avoid lifting of undercoats, as mentioned by Harvey,[6] has proved successful from both the application and the durability angles. However, on a new steel tank, partially covered with mill scale, peeling of portions of the entire film was experienced within six months after application of this same system, which was preceded by a weak phosphoric acid solution wash, the purpose of which was to improve adhesion of the primer and passivate corrosion products on the surface. Apparently some of the phosphoric acid was left unreacted on the surface, especially on the mill scale on which this type of metal preparatory solution has little reaction effect.

Because aluminum pigment in a paint film is rather quickly disintegrated on exposure to acid or alkali conditions, gray paints formulated with titanium pigment and colored with lamp black to an aluminum-gray shade have proved to be much more resistant. For resistance to mild acid attack, these grays are formulated with alkyd types of vehicle, while chlorinated rubber types are incorporated into those for exposure to alkali.

For most exterior chemical exposure, the cost-durability ratio has been experimentally proved to be too high to justify very extensive usage of the vinyls although these are economically advantageous for use on limited surface areas where short-term replacement of equipment is necessary due to chemical corrosion.

Figure 5. Underside of a Roof of an 80,000-Barrel Tank Taken Shortly After Application of a Five-Coat Vinyl System.

Some failures, based on economics involved and caused mainly by corrosion developing underneath the coating film and resulting in almost complete loss of adhesion after about two years, have been experienced in experimental applications of vinyl type coatings to interiors of sour distillate rundown tanks, while an economic advantage has been proved by others. The durability of these applications has ranged from two to four years.

The economics of experimental applications of vinyl type coatings to vapor-space interiors of sour crude storage-working tanks has not yet been definitely proved, because metal failures have not occurred in three or four years since applications were made. This is insufficient time to show cost justifications without making detailed interior inspections. It has been impossible to make such detailed inspections, because of continuous service of these 80,000 barrel tanks.

Figures 5 and 6 are photographs of the underside of a roof and vapor space of one of these tanks taken

shortly after application of a five-coat vinyl system and before the tank was put back in service. The vinyls have a very definite heat limitation and will not withstand steaming commonly used in refineries for gas freeing vessels without blistering.

One baked phenolic coating application has been made on the entire interior of a 10-foot-diameter by 70-foot-long, horizontal, cylindrical propane storage drum. On inspection after only eight months of service, this coating had blistered considerably along the bottom. This was attributed to inability of the applicator to obtain a sufficiently high baking temperature with heated air circulation, although the tank was completely insulated on the exterior with glass wool blanketing. Baking temperatures of about 275° F. were claimed by the applicator to have been reached, but an air outlet temperature of only 190° F. at the bottom of the tank was observed. In shop oven-baked phenolic coating work it is understood baking temperatures in the order of 300° to 450° F. are obtained.

Selection of paints for hot surfaces exposed to weather presents a special problem. For temperatures above 200° F., primers are not recommended. Low solid content heat resistant aluminum, special heat resistant black and high zinc dust content gray paints are used for temperatures above about 350° F. Most critical surface temperatures are from 200° to 350° F. and one-coat applications of medium oil alkyd or oil type paint containing some graphite seem to be about as good a choice as any for this temperature range. Operating conditions in most cases prevent proper practices of sand blasting, and following application bringing them gradually up to maximum operating temperature immediately after drying. Because corrosion prevention is not the primary purpose of painting these hot surfaces, but rather appearance, high cost is hardly justified.

It has been found that frequent recoating of most above-ground oil transfer pipe lines in open conduits with low cost coal tar paint is more economical than application of better quality systems requiring expensive surface preparation. Wrapping pipe with polyethylene or vinyl adhesive tape has proved to be more economically advantageous than paint coatings in some locations where the pipe is subject to severe chemical attack or high moisture conditions. Hot applied coal tar enamels are used on some of the water handling equipment.

Corrosion engineers' primary interest in paints and painting practices is only in their use in protecting equipment surfaces from deteriorating attack by destructive forces. To protect these surfaces to economic advantage should be the main object in this phase of corrosion mitigation. However, in connection with refinery painting, certain other economic aspects must be considered. Surface preparation methods and application of paint systems known to give best protection, but requiring idle equipment, must sometimes give way to less desirable systems that allow plant production, the income from which overshadows increased cost resulting from more frequent painting. Appearance of a well painted plant also has a certain advertising value and this, along with other factors such as the effect on employee morale and efficiency, etc., cannot be measured in dollars and cents.

Purely from the protective angle and to a certain extent from that of appearance, the economics of painting vs. non-painting, or that of one painting system compared with another, may be fairly conclusively proved through a study of durability results developed from a comprehensive program of intelligently planned, practical field test applications in which actual costs and corrosion rates are given due consideration.

It should be kept in mind, that cost-per-gallon of paint is a poor criterion for gauging the economic value that may be derived from this variable commodity. A low cost-per-gallon system may run considerably higher in cost-per-unit-area of applied dry film than one of much higher cost-per-gallon. Therefore, cost-per-unit-area of applied dry film per time-unit of durability, both from the protection and appearance viewpoint, based on plant scale applications, made under normal plant operating conditions, constitute the recommended method by which painting systems can be evaluated concretely.

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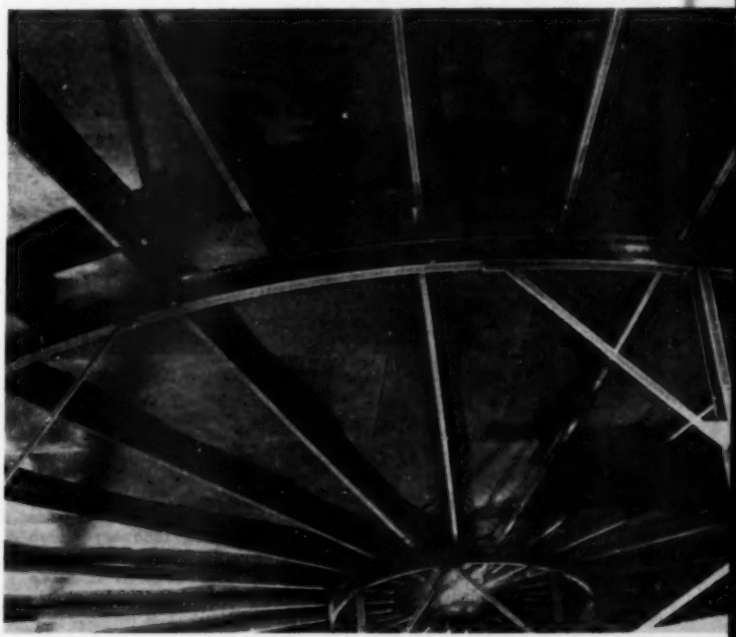
Figure 6. Vapor Space of Same Tank as in Figure 5. Both were taken before tank was put back in service.



SHALE OIL Production And Refining Today

Part II

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EXTRACTION of oil from bituminous shales involves low-temperature carbonization. The main distinction from coal carbonization processes is the formation of a non-saleable residue. Emphasis must therefore be placed on maximum recovery of oil and utilization of the nondistillable carbon residue by gasification or combustion.

Of the numerous retorting processes described in the patent literature,[1] only a relatively small number have achieved industrial significance. Consideration in the present paper is of necessity confined to the more important types which have either been commercially established or which have shown a definite favorable potential.

Essentially all of the useful shale oil carbonization processes may be classified according to the following scheme:

A) Externally Heated Retorts:
1) Stationary (e.g. Pumpherston, Young, Krupp-Lurgi)
2) With Movable Parts:
   a) Horizontal Rotary (e.g. Davidson)
   b) Vertical Rotary (e.g. Bamag-Meguin, Marecaux)

B) Internally Heated Retorts:
1) Upward Gas Flow (e.g. Pintsch, Socony-Vacuum, Fluidized Solids, Eesti-Kivoli Tunnel Kiln)
2) Downward Gas Flow—Batch (e.g. N-T-U, Royster, Lurgi-Hubmann)
3) Downward Gas Flow—Continuous (e.g. Union Oil Company, Counterflow Retort)
4) Horizontal Gas Flow (e.g. Gas-Flow Retort, Grande-Paroisse)

The objective in each retorting process is to heat large quantities of shale rapidly and uniformly and to minimize the troublesome formation of asphalt. Externally heated retorts, particularly suitable for carbonization of shale which tends to become friable in the course of retorting, must transmit the entire required heat through a substantial thickness of poorly conducting oil shale. As a result, the outer layers of the charge are exposed to the critical asphalt-forming temperatures (around 750°F.) for a relatively long time. Under these conditions, certain rich shales tend to form a liquid paste which is difficult to handle. At the same time, coke formation will set in at the heating walls; and unless provision is made for the immediate removal of coke, the wall temperature may reach dangerous values.

As a result of the much higher heat transfer rates encountered in internally heated retorts, the critical asphalt-forming temperature range is rapidly traversed. Most of the asphalt formed is quickly decomposed to product oil. Furthermore, the distillate is swept from the reaction zone, thereby minimizing its subsequent destruction by secondary cracking, or (as claimed by Luts[2]) by reaction with calcium oxide contained in the mineral portion of the shale.

In internally heated retorts, the shale is contacted directly with hot flushing gases. For this purpose, either highly superheated steam, externally heated recycle gases (derived from the shale distillation process), or hot combustion gases may serve to advantage. The main advantage of steam is the ease with which the product can be condensed from the carrier gas. By-product gases have a high heating value, as they do also when recycle process gases are used for retorting. The main advantage of using hot combustion gases is the much greater simplicity of the installation. Fuel for the generation of these gases is usually the residual carbon content of spent shale. If combustion gases are used, the by-product gases of the distillation are highly diluted, suitable only for internal plant use or, in some cases, actually non-combustible.

An alternate source of heat is the hot residue of burned shale. This may be recycled as is and mixed with green shale in fluidized solids operation. Another approach (used in the counterflow retort) is to pass process gases through the hot clinkers and transmit the recovered heat to the retorting stage.

Where the flushing gases are preheated externally, a tubular furnace or recuperative (or pebble) stoves may serve as auxiliary equipment.

The generation of hot combustion gases from spent shale may take place either in a chamber kept separate from the retort, or in the same enclosure as the retort itself. In the latter case, it is necessary that the gas flow be directed downward. Otherwise, distilled oils will condense on the cool shale near the outlet of the reactor and will reflux into the combustion zone where they are at least partly destroyed.

For reasons of lower labor costs, continuous processing is preferable wherever it may be suitable (shales below 40-50 gallons per ton). Most designs involve gravity flow of the shale. At least two units, based on forced upward flow of the shale, have now been proven on a pilot-plant scale (The Union Oil Company of California and U. S. Bureau of Mines counterflow retort). This latter approach permits the countercurrent flow of shale and heating gas, thus resulting in maximum thermal efficiency and in considerable cooling water savings since the cold green shale itself will serve to aftercool the distillate gases.

No one retort is a panacea for all shale carbonization problems. Selection of the proper retort depends on the size of the plant, economic conditions encountered locally, and on the ash content, oil yield, ash fusion point, and physical characteristics of the shale being handled.

THE U. S. BUREAU of Mines recently announced that it will build a much larger plant for the production and refining of shale oil. This project, together with the recent dangerous developments in Iran, has again placed the subject of shale oil in the limelight. The amount of crude oil available from U. S. shales is tremendous, and has been estimated in excess of 225 billion barrels.

Part I of the series outlined the occurrence and nature of shale oil deposits. Part II describes the retorting processes for shale oil recovery which have been commercially established or which have shown a definite favorable potential.

Modern American Processes

Recent American research has tended to discount externally heated retorting methods and has been concerned solely with processes in which hot gas is in direct contact with the shale. Advantages derived from the higher heat transfer rates and the elimination of costly heat transfer walls are evident and are believed to outweigh the main disadvantages of internally heated retorts, to wit: the need for larger condensation equipment* and for gas blowers and similar auxiliary units. Use of internally heated retorts is limited in some foreign countries by the physical characteristics of the shale being processed. No such limitation exists for America's most important (Green River) oil shales.

Of the numerous retorts which have been studied in the course of America's oil shale development program of the past few years, detailed description will be accorded here to the more important and representative types.

Retorting by the Fluidized Solids Technique

Much promise is implied in the application of the fluidized solids technique to the retorting of oil shale. The important advantages are that temperature uniformity may be maintained throughout the retorting vessel and that the tendency of rich shales to stick and cake may be minimized.

An important consequence of uniform-temperature distillation is the possibility to operate in a temperature range in which high retorting rates can be achieved but which is still below the level where considerable secondary cracking results in the formation of large amounts of gaseous hydrocarbons at the expense of oil yield (Example: In fluidized operation, hydrocarbon gas formation increased from 4.5 to 15.2 weight percent (on shale) as the temperature was raised from 850-1000° F.).

These expectations have been confirmed on a pilot-plant scale by Esso Standard Oil Company.[3] The raw material for fluidized retorting was an unusually rich Australian shale assaying 63 weight percent carbon and 8 weight percent hydrogen. It was found that this material could indeed be carbonized in this manner without the formation of conglomerates and other obstructions in the retorting vessel, a property which is a frequent obstacle in the solid-bed distillation of rich shales.

It was found that the oil recovered in the course of fluidized solids retorting had a considerably lower API gravity than the oil obtained in the laboratory batch distillation of the same raw material. The explanation for this observation may be found in the cracking characteristics of the oil. This particular shale oil was cracked readily at temperatures as low as 550° F. It appeared, therefore, that the oil obtained in the course of batch distillation was thermally decomposed to a much greater extent than was true of the distillate obtained at the uniform temperature conditions and the short residence time prevailing in the fluidized solids retort.

The basic design of the fluidized solids unit employed for the pilot-plant retorting runs differed little from fluidized catalytic cracking units employed widely throughout the petroleum industry. Ground shale was fed to the top of the reactor, just below the disengagement space. The carrier gas fed to the retort was a mixture of air and steam. The air was rapidly consumed in the combustion of carbon on the spent shale as well as of some hydrocarbon vapors which were evolved in the process. The entire gaseous phase was taken overhead, cooled, and freed of fines. The spent shale was withdrawn through a seal at the bottom of the reactor.

In the case of the Australian shale employed in the pilot-plant studies, the hydrogen/carbon ratio was relatively low and, as a result, "coke" formation was considerable (the residue contained 33.5-43.2 percent carbon, 1.2-2.7 percent hydrogen). This material can either be burned in steam boilers or gasified for the production of water gas (which may serve as raw material for Fischer-Tropsch synthesis, hydrogen production, or for other purposes). At any rate, the heating value of the spent shale greatly exceeds the fuel requirements of the distillation process in this instance.

Due to the high degree of dilution with nitrogen of the combustion air, this retorting operation yielded a low-value (200-250 Btu per cubic foot.) by-product gas.

In all retorting operations, the time-controlling factor is the rate of heat transmission to the shale particles. The very favorable coefficients which prevail in fluidized solids technique permitted residence times as low as eight minutes. Nothing was gained by further increase in contact time. This compares with hold-up times of 60 to 160 minutes in more conventional retorts. Space requirements are, of course, not reduced proportionately because of the considerably lower bulk density encountered in fluidized operation. As a result, charge rates as high as 500 to 1250 pounds shale per hour per square foot reactor cross-section were possible. These values are six to twenty times higher than the design data employed for solid-bed retorting processes.

The principal drawback of the pilot-plant technique is the combustion of some of the potential oil yield and the formation of a very weak by-product gas. These objections can presumably be overcome by commercial operation in accordance with the scheme shown in Figure 1. Here, the burning and retorting functions are undertaken in separate chambers. Spent shale from the retorting vessel is partly withdrawn from the system. The remainder is conveyed—still in the fluidized state—to a combustion vessel where its carbon content is consumed by reaction with air. The highly preheated spent shale is recycled to the retorting chamber where its sensible heat serves to fill the heating requirements of green shale drying, preheating, and carbonization. Steam or recycle make gas may serve as stripping and carrier medium in the reactor. As a result, the degree of dilution of the make gases will be small, and all the distillable oil will become available for recovery.

Blanding and Roetheli[3] state that the fluidized solids technique can be applied with equal success to American shales as to the rich Australian materials on which they reported. Shale tonnage throughput should be greater in the case of the leaner American shales in view of their smaller specific heats and lower oil content. Of course, the oil output per square foot of reactor cross-section is expected to be greater in the case of rich shales.

For economic success in any given installation, the stated advantages of the fluidized solids retorting technique must bring sufficient savings to offset the not inconsiderable cost of crushing and grinding green shale to the fluidized size range. This technique may, however, be considered supplemental to other retorting methods for the utilization of fines unavoidably obtained in the crushing operation.

Retorts Analogous to TCC Furnaces

Another successful American development in catalytic cracking technique which can be adapted to oil shale retorting is the TCC (thermofor catalytic cracking) process.

During the war, Socony-Vacuum Oil Company carried out successful pilot-plant studies along this line. A

*Note, however, that some internally heated processes (tunnel kilns, Grande-Paroisse) avoid the use of large condensation equipment by using reheated distillation gases for retorting purposes.

retort pipe of six inches diameter and ten feet length was used. Ground shale was fed to the top of the unit and was permitted to flow downward by gravity, countercurrent to hot gases which supply the heat required for the retorting process. In the pilot-plant work, superheated steam was used for this purpose. A portion of the superheat was obtained by contacting saturated atmospheric steam with hot spent shale inside a special chamber at the bottom of the retorting unit. Typical operating conditions, as reported by Payne and co-workers[4] are shown in Table 1.

If steam, instead of flue gas, is employed for retorting purposes, the by-product distillation gases are relatively undiluted and have a high heating value. After condensation of oil and carrier steam from the pilot-plant TCC retort, the residual mixture of carbon monoxide, hydrogen, and light hydrocarbons had a heating value of 600 Btu per cubic foot. Operation at 1000° F. yielded 1500 cubic foot retort gas per ton shale retorted. At 800° F., the by-product gas was reduced to roughly one-half that value.

Of particular importance to the successful execution of TCC retorting is constancy in the over-all volume and shape of the shale particles being retorted. This condition is met by a large variety of shale rocks but is not universally satisfied. Pronounced coking or disintegration characteristics may be expected to result in erratic flow and will impose serious limitations on the usefulness of this particular process.

The use of superheated steam is too expensive to be suitable for normal commercial operation, and retorting by means of hot flue gases or process gases is contemplated for large-scale processing. As visualized by Socony-Vacuum Oil Company, crushed raw shale is supplied from an elevator to the storage hopper at the top of the TCC retort. From here it flows downward, entering first the preheating zone where its temperature is raised to 500° F. (i.e. still below retorting temperature) by means of flue gases. Continuing its downward flow, the shale now enters a separate retorting chamber where its temperature is raised to 1000° F. by means of properly controlled hot process gas. Holdup time in the retorting zone varies between 60 and 160 minutes.

The overhead stream, containing all the distilled oil and retort gases, is quenched or condensed and cooled in surface heat exchangers (whereby special design attention must be given to the shale fines carried by the top gases, which tend to foul condenser surfaces).

The spent shale is cooled by a steam purge and is discharged from the bottom of the TCC retort via a seal leg. This material still contains some five per cent carbon.

An alternate approach to the process would utilize flue gases (from the combustion of carbon in the spent shale) for retorting as well as for preheating purposes. This operating mode has the advantage of lowering

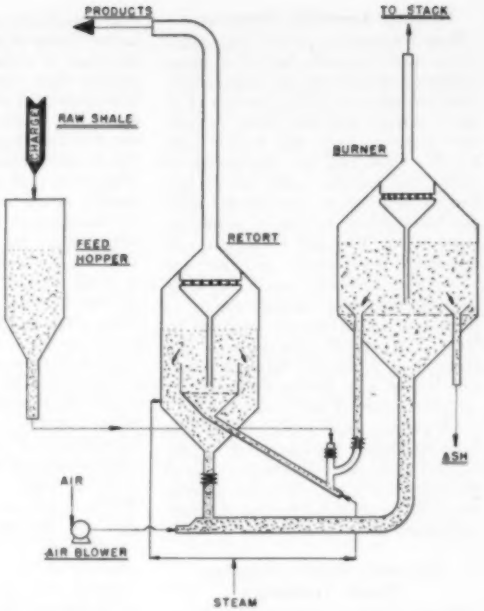

Figure 1. Fluid Oil-Shale Retorting Process. From U. S. Bureau of Mines R.I. 465 2(1950).

TABLE 1

Experimental Retorting Conditions and Product Yields in Recovering Oil from Shale

Method of Supplying Heat	Super-Heated Steam	Super-Heated Steam
Experimental Run No.	19	20
Operating Conditions:		
Rates: Raw Shale:		
Lbs./Hour	35.0	36.7
Lbs./Hour/Sq. Ft. of Retort Cross-Section	175	183
Residence Time in Retorting Zone, Minutes	117	112
Superheated Steam, Lbs./Hour	29.5	31.4
Cooling Steam, Lbs./Hour	16.5	17.0
Temperatures:		
Vapor above Bed, °F.	592	615
14 In. Down Bed, °F.	798	755
Maximum Retort Temperature, °F.	972	902
Retorted Shale Discharge, °F.	414	419
Superheated Steam Inlet, °F.	1010	908
Cooling Steam Inlet, °F.	212	212
Particle Size of Shale Charge, In.	¼—⅝	¼—⅝
Yields, Based on Charge:		
Retorted Shale, Weight Percent	74.7	78.2
Oil, Weight Percent	15.8	14.2
Gallon/Ton of Shale	40.7	39.6
Retort Gas, Weight Percent	6.2	3.7
Cu. Ft./Ton of Shale	1560	955
Loss, Weight Percent	3.3	3.9

TABLE 2

Typical Operating Conditions and Yield Data, Royster Pilot-Plant Operations

Type of Operation	Circulating Gas	Super-Heated Steam	Small-Scale N-T-U
Operating Conditions:			
Grade of Shale (Fischer Assay) Gal./Ton	30.0	31.6	31.5
Quantity of Shale Charged, Lb.	1,400	1,312	1,389
Particle Size, Inches	+0.5—1.0	+0.5—1.0	+0.5—1.0
Retort Inlet Temperature, °F.	1,150	1,095	[1]1,919
Retort Lower Bed Temperature, Max. °F.	950	843	....
Retort Space Velocity[2], Ft./Sec.	4.2	2.9	0.4
Recycle rate, s.c.f.m.	207	....	24.6
Steam Input, Lb./Minute	....	7.1	....
Steam Consumption, Lb./Lb. Shale	....	1.4	....
Air Rate, s.c.f.m.	....	....	29.2
Air: Recycle Gas Ratio	....	....	1.2
Retorting Rate, Lb. Shale/Hour	560	312	302
Length of Run, Hours	2.5	4.2	4.6
Yields:			
Oil Recovered, Volume Percent Fischer Assay	102	96.5	99.2
Oil Recovered, Gal./Ton Raw Shale	30.6	30.5	31.2
Gas Production, Ft.[3]/Ton Shale	1,750	3,760	[3]3,280
Fog and/or Vapor Loss, Percent Fischer Assay	5—7	....	9

[1] Maximum retort temperature.
[2] Based on superficial velocity in retort at retorting conditions corrected for voids in shale bed.
[3] Total vent gas (14,400 S.C.F./T.) minus air input (11,140 S.C.F./T.)

investment and maintenance costs. However, the retorting gases will have a very low heating value (50-180 Btu per cubic foot.) and will have no external sales value. This modification should be suitable for retorting at considerable distance from fuel gas markets.

Counterflow Retorts

If the heat-carrying gases are to be generated by combustion of the residual carbon content of spent shale, it is either necessary to carry out the combustion in a chamber wholly separated from the retort proper, or else to provide combustion at the top of the unit and to withdraw the products of distillation and combustion at the bottom. Any other arrangement will result in refluxing of the distillate oil which is condensed in the cool portions of the retorting chamber, and the consequent destruction of this valuable product as it enters the hot zones.

A number of processes (e.g. N-T-U and Lurgi-Hubmann) are accordingly designed with downward flow of the entire gaseous system. Since in all such units the shale is either stationary or moved by gravity, the gas flow is cocurrent with the solid burden, with consequently low heat economy.

This problem has been attacked with considerable success by the continuous countercurrent retort of The Union Oil Company of California. The unusual feature of this unit is the upward motion of the shale charge, countercurrent to the retorting gases and the distillate. The unit consists of a cylindrical kiln with an underfeed mechanism which causes the shale to move upward through the retort. Spent shale overflows at the top, where it is removed by a scraping mechanism and dropped into an ash disposal chute.[5]

Air is taken in at the top of the unit and meets the shale counter-currently. In the course of its downward flow it is consumed by the process of burning residual carbon from the spent shale in the combustion zone near the top of the unit. The hot flue gases, so generated, continue their path downward, effecting the desired distillation in the retorting section of the same cylindrical unit. In the course of the distillation the temperature of the system is rapidly diminished, and the gases are finally cooled to a temperature just above ambient level in the shale preheating section near the bottom of the unit. As a result, the distillate is condensed and is carried out of the unit, along with the downward flowing gases, through a conical section at the bottom of the unit which is provided for the purpose of separating the oil and gas from the incoming shale.

The process has the important advantage of the high heat efficiency which is inherent in countercurrent heat exchange. At the same time, the shale itself serves as cooling medium for the retort gases and oils and minimizes the need for cooling water. The process thus promises to overcome a most serious obstacle to shale retorting in many shale-rich areas which are deficient in adequate water supplies.

The main difficulty inherent in the process is the large reliance on mechanical moving parts. Very high temperatures (up to 2400° F.) are encountered in the combustion zone and proper materials of construction, capable of withstanding these temperature levels as well as the abrasive action of the moving shale must be provided.

The off-gases from the process are of very low quality but constitute a sizable portion of the total heating values recovered. Thus, according to Reed and Berg,[5] up to 49 percent of the total thermal energy available in the recovered oil from 30-gallon-per-ton shale was present in retort gas with a gross heating value of 79 Btu per cubic foot. This gas cannot, of course, be economically transmitted via pipe-line and it must be utilized at the plant site for the production of power. Reported oil recovery efficiency with this unit is up to 102 percent of the Fischer laboratory assay.

Another unit in which shale movement is at least partly in upward direction is the *counterflow retort* of the U. S. Bureau of Mines. Here, a hydraulic ram moves green shale up an inclined retort in counterflow to hot process gases. Upon completion of the carbonization step, the spent shale drops through a rotary valve into a separate combustion chamber where residual carbon is burned. The heating value is recovered in a waste heat boiler through which the combustion gases are passed. The hot clinkers finally enter by gravity flow into a heat exchange chamber where they give up their sensible heat to process gas which is circulated between this zone and the retort proper. The process combines good thermal efficiency with the production of a relatively rich by-product gas. Unquestionably, several severe engineering problems will still have to be overcome. Operating results on this unit have not yet become available.

The N-T-U Retort of the U. S. Bureau of Mines

This batch-type retort was originally developed in the United States. It has been used commercially in Australia and is at present being studied on a "demonstration plant" scale (two 40-ton capacity retorts) by the U. S. Bureau of Mines at Rifle, Col.

In essence, the unit is a large hollow vertical cylinder, provided with a shale-supporting grate and a hinged bottom. The same chamber serves for both retorting and combustion purposes. As has been seen in connection with The Union Oil Company retort, this means that the carrier gas flow must be directed downward through the shale.

Accordingly, a batch in the N-T-U retort is started by kindling a fire at the top of the shale charge and causing air (or a mixture of air and combustion gases) to flow from the top to the bottom of the unit. The hot combustion gases serve to distill shale oil further down along their path. The residual carbon from the retorting operation is, in its turn, consumed by incoming air.

Thus, there exist two distinct zones in the N-T-U retort: a combustion zone where spent shale is burned by air and, below this region, a retorting zone where the hot combustion gases distil and strip the oil from the green shale. As the upper layers of shale become depleted, both of these fundamental zones move in downward direction, until the entire charge has been successfully retorted.

In the early stages of operation, the lower portions of the shale bed serve to cool and condense the reaction products. Eventually, as the hot zones move downward, all the cooling functions must be provided by external means. By proper operational synchronizing of a number of N-T-U retorts it becomes, however, possible to take maximum advantage of the cooling capacity of the unspent green shale and thus to minimize cooling water requirements for the retorting plant as a whole.

The off-gases are so highly diluted with nitrogen and carbon dioxide that they are usually non-combustible. The ratio of recycle combustion gases to air must be carefully controlled. If the air concentration is insufficient, combustion cannot be supported. On the other hand, very high air ratios will result in excessive temperatures with consequent danger to the retort and operational difficulties due to carbonate decomposition, ash fusion, excessive coking, and consequent channeling through the shale bed. A further drawback of high-temperature retorting is decreased oil yield.

Of similar importance is the air velocity. The rate of combustion is basically only dependent on the rate

at which air is supplied. On the other hand, the retorting rates are determined by the heat transfer coefficients encountered. It follows that an excessive air rate will move the combustion zone in the direction of the retorting zone. Eventually, the combustion zone may actually overtake the carbonization zone, with consequent destruction of all or part of the kerogen and decrease in the oil yield.[6]

Even under carefully controlled conditions, some coking will be encountered in the retorting of a number of shales. Lankford and Guthrie[7] report that, kept within reasonable bounds, this coking tendency is not too serious a problem in the operation of N-T-U retorts which are constructed with a downward taper and a wide-opening hinged bottom for the rapid discharge of the entire spent shale.

According to Lankford and Guthrie, oil yield varies between 90 and 100 percent of the Fischer assay value. With a 30-gallon-per-ton Colorado shale, a cycle time of approximately 18 hours is required (this includes charging the retort, making the run, discharging the retort, and preparing for the next run). Actual cycle time is variable and depends on the exact operating conditions chosen.

N-T-U retorts have the advantage of simplicity, flexibility, and low investment costs. They are, however, thermally inefficient and wasteful of potential heating values in process gases which can be recovered in other processes.

The Royster Retort

This unit, being studied on a pilot-plant scale by the U. S. Bureau of Mines is similar in basic design and principle to the N-T-U retort. The principal difference is that the flushing gas is preheated outside the retort proper and that therefore the heating value of spent shale must be exploited in a separate installation. The main advantage is the formation of more valuable by-product gas.

The Royster retort has been operated by the Bureau of Mines according to three different schemes: 1) Retort gas is heated externally and is recycled to the unit to serve as heat carrier and stripping medium; 2) steam is superheated externally and fed to the top of the retort to serve as heat carrier and stripping medium, and 3) air is fed to the top of the unit (in mixture with combustion gases) and the retort is operated in the manner of an N-T-U unit; i.e. the heat requirements are covered by internal combustion of spent shale.

TABLE 3

Typical Product Inspections, Royster Retorting Operations

Type of Operation	Circulating Gas	Super-Heated Steam	Small-Scale N-T-U
Crude Oil:			
Gravity, °API at 60° F.	20.1	20.1	21.4
Specific Gravity at 60° F.	0.9334	0.9334	0.9254
Viscosity, SUS at 130° F.	163	165	115
Viscosity, SUS at 210° F.	52	53	48
Pour Point, °F.	90	95	90
Flash Point (C.O.C.), °F.	240	250	244
Nitrogen (Kjeldahl), Percent	1.75	1.65	1.80
Sulfur, Percent	0.65	0.77	0.70
100 ml. Distillation (Corr. to 760 mm.):			
I.B.P.	250	207	221
2 Percent	400	406	412
5 Percent	443	450	454
10 Percent	494	504	497
30 Percent	619	650	614
50 Percent	**659**	**682**	**668**
60 Percent	669	696	681
70 Percent	683	.....	692
E. P.	683	700	692
O. H. Rec., Percent	75	69	73
Product Gas:			
Density, Lb./Ft.³ at S.C.	0.0566	0.0758	0.0825
Molecular Weight	21.43	28.71	31.20
Net Heating Value, Btu./Ft.³	350	172	.....
Composition, Mol., Percent:			
Hydrogen	27.9	28.3	1.4
Hydrocarbons	12.7	4.7	1.8
Illuminants	1.0	1.4	0.2
Oxygen	.....	2.3	1.6
Carbon Monoxide	25.5	1.1	4.4
Carbon Dioxide	11.3	50.3	29.5
Hydrogen Sulfide	Trace	1.9	Trace
Nitrogen (By Diff.)	21.6	10.0	61.1
Spent Shale:			
Fischer Assay, Gal./Ton Raw Shale	0.2	0.2	0.15
Organic Content (Carbon + Hydrogen) Weight, Percent	2—3	1.0	0.1

In all three cases, the oil product was remarkably similar in composition (for any given set of time-temperature conditions). Typical operating conditions and product inspection for each mode of operation are shown in Tables 2 and 3.[8]

The separation of combustion and retorting steps permits a quantitative evaluation of the effect of different variables on the retorting characteristics of the Royster—N-T-U unit. It has been shown[5] that high oil yield is favored by decreasing temperature and shale particle size; the space velocity function passes through a maximum oil yield value. The higher the Fischer assay value, the more complete will be the extent of oil recovery. In this connection, it must be noted, however, that serious coking difficulties were encountered with Green River shales assaying higher than 50 gallons per ton. Such shale made the Royster unit inoperable.

Retorting rate is favorably affected by increased space velocity and gas temperature, both of which tend to improve heat transfer characteristics.

Gas-Flow Retort

This unit, which is also part of the U. S. Bureau of Mines pilot-plant program, permits the crushed shale to flow downward through a set of louvers. Hot gases are passed through the unit at right angle to the shale flow. Gas distribution is arranged to assure a positive temperature gradient from the top to the bottom of the retort. This design is thermally quite inefficient but it has the advantage of minimizing residence time of the distilled oils in the hot zone, thus reducing losses due to secondary cracking. At the latest report, this unit still offered considerable operating difficulties due to coking at the downstream side of the louvers. This design is similar to the retort of the Societe Chimique de la Grande-Paroisse which has been operated commercially at Saint-Hilaire, France.

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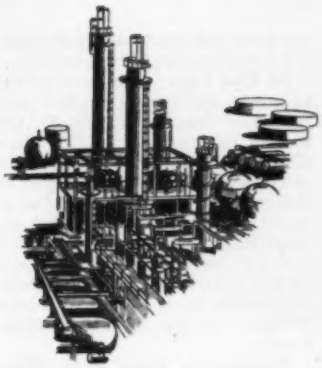
End of Part II. Part III will appear in an early issue.



Prospects Brighter for Increase of Steel Rations to Oil Industry

ROBERT E. SPANN
Eastern Editor

THE outlook for increases in steel rations to the petroleum industry is growing brighter with the steady rise in over-all producing capacity of mills and the indication that military consumption of steel will be spread over a longer period.

Barring any additional emergency military requirements for an increased rate of defense buildup, allocations of steel for petroleum operations are believed to have reached the low point in the first quarter of this year and a steady improvement in steel availability can be expected in the latter part of the year and in 1953. There are no indications that over-all allocations to the industry will be increased this year, but if present plans of Petroleum Administration for Defense officials materialize, larger allotments to some branches of the oil and gas industry can be looked for later this year without corresponding reductions in supplies to other industry divisions.

Allocations of steel so far under the Controlled Materials Plan, which became fully operative starting with the fourth quarter of 1951, have most restricted the expansion programs of the transportation and refining branches of the industry. While the total availability of carbon steel plate urgently needed by both of these divisions will continue tight into the foreseeable future, enough improvement in supply is expected to permit pipe line and refinery capacity expansion programs to be increased some to catch up with the additions that have been made in crude production capacity during 1951 and the latter part of 1950.

With total petroleum demand on the U. S. expected to average 7,841,000 barrels daily during 1952, an increase of 5.4 percent over last year, the most optimistic forecasters estimate that the availability of materials will permit the petroleum industry to expand to keep pace with demand but with no opportunity, however, to build reserve capacity above actual

SUFFICIENT IMPROVEMENT is expected in the steel supply to allow pipe line and refinery programs to partly catch up with the expansion in crude production capacity. This would be accomplished, however, without an over-all allocations increase. With total petroleum demand in the U. S. expected to increase 5.4 percent over last year, some forecasters believe steel supplies will just enable the industry to meet the new needs but will not permit the building of a reserve capacity.

TABLE 1

Petroleum Industry Steel Allocations Under Controlled Materials Plan
(TONS)

	1951		1952	
	Third Quarter	Fourth Quarter	First Quarter	Second Quarter
TOTAL, ALL STEEL	1,808,912	1,806,500	1,708,700	1,709,500
Domestic Operations	1,676,622	1,721,500	1,658,747	1,642,500
Foreign (including Canada)	132,290	85,000	80,000	67,000
Carbon Steel	1,606,200	1,670,000	1,595,000	1,602,000
Alloy and Stainless Steel	202,712	134,500	113,700	107,500
Division by Principal Industry Use:				
Oil Country Tubular Goods	468,694	415,700	440,000	450,000
Plate (Line Pipe and Tanks)	890,000	625,000	585,000	565,000
Oil and Gas Producing Total	503,975	477,376	487,353	530,886
Carbon	n.a.	413,400	448,950	492,779
Alloy	n.a.	63,975	38,400	38,100
Stainless	n.a.	1	3	7
Natural Gas Prod. and Proc., Total	107,844	97,800	47,954	61,143
Carbon	n.a.	97,400	47,737	61,006
Alloy	n.a.	400	50	122
Stainless	n.a.	.....	167	15
Gas Transmission and Distribution, Total	557,000	491,301	346,277	337,315
Carbon	n.a.	490,101	343,800	335,306
Alloy	n.a.	1,200	2,475	1,984
Stainless	n.a.	.....	2	25
Oil Transportation Total	367,593	292,208	433,979	423,445
Carbon	n.a.	291,800	433,950	423,105
Alloy	n.a.	400	25	295
Stainless	n.a.	8	4	45
Refining Total	106,400	166,800	125,200	158,472
Carbon	n.a.	162,000	121,050	149,575
Alloy	n.a.	2,800	2,075	7,415
Stainless	n.a.	2,000	2,075	1,482
Marketing Total	6,000	5,500	2,150	3,850
Carbon	n.a.	5,500	2,150	3,849
Alloy	n.a.	.....	.....	.....
Stainless	n.a.	.....	.....	1
Oil Field Machinery and Equipment Total	180,100	210,000	198,075	180,009
Carbon	n.a.	147,250	132,150	122,000
Alloy	n.a.	62,000	65,000	57,084
Stainless	n.a.	750	295	925
Maintenance, Repair and Operating Total	b	75,515	45,025	b
Carbon		72,549	42,863	
Alloy		1,725	1,975	
Stainless		1,241	187	
Reserve Steel Held by PAD Total (c)	.....	.....	20,734	14,380
Carbon			20,350	14,380
Alloy			.....	.....
Stainless			384	.....

Notes: n.a. Complete breakdown not available.
b Not listed separately but included in total for industry divisions.
c Not established in the third quarter, established but later allocated in fourth. To be allocated in first and second.

needs requested by the military. For the refining branch a sharp increase in steel allocations is considered essential if the industry is to have refining capacity by the end of this year to keep up with the presently indicated demand.

Total allocations of steel to the industry in the first and second quarters of this year (see Table I) are lower than granted in the final two quarters of 1951, but PAD anticipates petroleum operators this year will receive a higher percentage of the allocation than was experienced last year.

The second quarter volume of steel to be made available for oil and gas operations will be slightly larger than was granted the industry for the current three-month period, but the allotment for both quarters of this year is far below the original plans developed by PAD. On an over-all basis, allocations of steel to the petroleum industry for the first six months of this year will support a 1952 drilling program of 43,900 wells.

Steel availability for the principal branches of the industry for 1952 appears as follows:

Production: Total steel allocated for oil and gas production operations for the first six months amounts to 1,018,239 tons, compared with 981,351 tons in the last six months of 1951. With its 1951 allocations from PAD, plus imported steel and oil country tubular goods used from inventories, the industry completed a record of 44,826 new domestic wells. While the higher allocation for the first two quarters of 1952 would indicate at least as many wells can be drilled this year, the strict Controlled Materials Plan covers steel used from inventories. Also, conversion tubular material, which gave operators extra steel in 1951, must now be counted against PAD allotments. While the present program is designed to permit completion of 43,900 new wells this year, industry sources estimate that based on present availability conservative use of allocated steel could result in a larger number of completions.

Late? Probably Not!

Some of the "little type" on the editorial index page advises "PETROLEUM REFINER, published on the 10th of every month," etc.

Attention is being called to this because some subscribers think that PR's publication date is around the 1st of the month and sometimes are a bit hasty about claiming non-receipt of issues.

This is not saying that we never miss. Even the Super Chief can't make that claim. But, generally speaking, you can bet on a 10th or 11th mailing date each month.

Oil Pipe Lines: Allotments of steel for crude and refined product pipe lines have been boosted to 857,416 tons in the first half of 1952 from 639,801 tons in the last six months of last year. A substantial volume of this could not be delivered due to shortages of steel plate needed for large diameter line pipe. Most all essential presently planned projects approved by PAD will be completed on schedule based on current volume of steel for the oil transportation branch.

Natural Gas Lines: Steel allocations have been reduced sharply from 1,048,301 tons in the final half of 1951 to 683,592 tons for the first half of 1952. Natural gas transmission projects were given priority last year so that essential lines to the East and Midwest could be ready for operation in the winter months. Due to the overall plate shortage and the continued need for large supplies of line pipe for crude and products lines, no substantial increase in plate allocations for gas lines can be expected this year, though some improvement is looked for possibly in the final months of 1952 or by early 1953.

Refining: Additions to refining capacity last year totaled 266,000 barrels daily, or less than the expansion in demand, with the result that reserve capacity of 400,000 barrels daily that had existed at the start of the year was depleted. Allocations of steel for the first half of this year to the refining branch have been increased slightly over the last half of 1951 to a total of 283,670 tons. Such an allocation is geared for a 1952 refinery expansion program of 330,000 barrels daily, some of which would be required to replace existing plants.

Recognizing the extremely tight refinery picture, PAD now is seeking approval of an increased refinery expansion program from Defense Production Administration to allocate enough steel for an annual construction of 475,000 barrels daily in new refining capacity. The earliest such an expanded program could be commenced would be starting with the third quarter of this year, and since one of the most needed steel items for refinery capacity additions is carbon steel plate, there are some doubts if materials will be available by July to permit an enlarged program without reducing allocations of plate to petroleum and natural gas pipe line projects. Industry leaders say that such an expanded program of refinery expansion could be accomplished if materials could be made available.

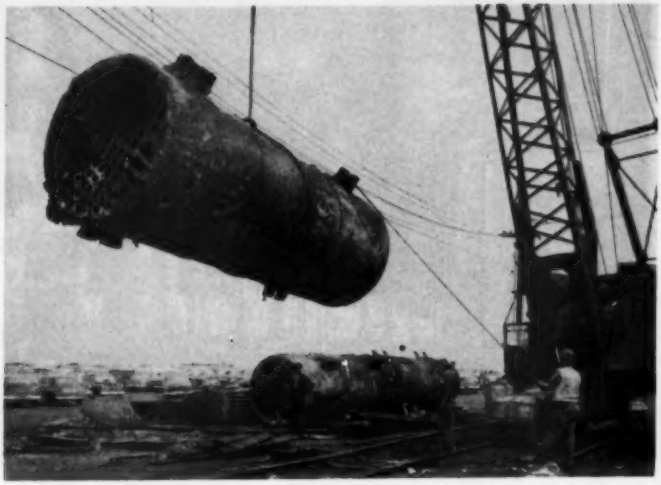
TABLE 2

Petroleum Industry Copper and Aluminum Allocations Under Controlled Materials Plan

(Figures in Pounds)

	1951		1952	
	Third Quarter	Fourth Quarter	First Quarter	Second Quarter
INDUSTRY TOTAL:				
Copper	10,100,000*	8,500,000	8,800,000	7,775,000
Aluminum	600,000*	785,000	1,250,000	1,240,000
Oil and Gas Producing:				
Copper	.....	260,500	257,000	530,886
Aluminum	.....	10,000	180,000	132,000
Natural Gas Producing and Processing:				
Copper	.....	502,000	513,000	584,000
Aluminum	.....	2,000	22,750	44,000
Gas Transmission and Distribution:				
Copper	.....	321,000	327,000	299,000
Aluminum	.....	2,000	74,000	60,000
Oil Transportation:				
Copper	.....	516,500	534,500	586,000
Aluminum	.....	8,000	78,000	71,000
Refining:				
Copper	.....	1,280,000	1,300,000	3,852,000
Aluminum	.....	150,000	157,000	209,000
Marketing:				
Copper	.....	10,000	14,000	34,000
Aluminum	.....	.....	1,800	4,000
Oil Field Machinery and Equipment:				
Copper	.....	2,365,000	2,459,000	2,150,000
Aluminum	.....	450,000	600,000	720,000
Maintenance, Repair and Operating:				
Copper	.....	2,840,000	3,180,500	†
Aluminum	.....	112,000	56,450	†
Reserve Held by PAD for Distribution:				
Copper	.....	315,000	15,000	.....
Aluminum	.....	51,000	80,000	.....

* Breakdown by divisions not available. † Not separated but included in division totals.



Scrap for the Nation's Defense. These obsolete boilers are part of 8000 tons of steel collected by Sun Oil Company in its scrap campaign.

Sun's Pilot Drive Offers Pattern for Collecting Scrap

AT THE request of the American Iron and Steel Institute, Sun Oil Company undertook a pilot scrap collection drive to be used as the basis for similar drives throughout the oil industry. This article describes how the drive was set up and conducted, and how it paid off, not alone in the salvage of scrap, but also in other ways, including greater safety, better appearance, and improved working conditions.

PAUL D. BARTON

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THERE is no easy way to conduct a "scrap-everything-possible" drive within a concern, but Sun Oil Company has worked out a practical procedure for itself that paid off in many ways.

Sun's drive originated as a direct result of a request from Robert W. Wolcott, chairman of American Iron & Steel Institute's committee on scrap, to set up a pilot operation for the petroleum industry.

Details of the campaign, which produced about 8000 tons of steel scrap and 140,000 pounds of copper and brass by February 1 for the "Scrap For Defense" program, are being made available in a report prepared for American Iron & Steel Institute.

In undertaking the job, which was to be over and above normal collection of scrap throughout the company, Sun reconciled itself to the prospect that a lot of money was going to be spent on the deal.

As it turned out, however, the pilot scrap-collection drive disclosed many more benefits than were foreseen when the goal was simply set on contributing sorely-needed scrap to the nation's steel mills.

In capsule form, these were the results:

- 8000 tons of steel scrap for the defense effort (and more coming).
- 140,000 pounds of hard-to-get copper and brass turned in as scrap.
- Elimination of usable but inefficient and expensive-to-operate facilities, thus cutting maintenance and operating costs.
- Disposal of obsolete, obsolescent and dormant inventory (parts, tools, derricks, casing, tubing, machinery).
- Gaining of an amazing amount of shop, plant and parking space in hitherto jammed-up refinery areas.
- Increase in safety factor through weeding out of hazards.
- Gain in good housekeeping which contributes to safety, plant appearance and efficiency of operation.
- Salvaged materials.

At the outset, it was agreed that top management would give its full support to the scrap drive.

A decision such as this is imperative, because otherwise the drive would fall far short of its potential.

Quite understandably, foremen in the plants and even middle echelon management will pass over marginal equipment or stagnant inventory if they believe that at some future date there may be repercussions from above for scrapping items that are not now of use, do not have foreseeable use, but conceivably at some time might be put to work at some job.

Having established the premise that everything scrapable was to go, Sun appointed local committees to look at all facilities and make decisions on the spot.

In the small percentage of cases where great expense or change in operations were involved, top management decision was asked.

Experience at Sun's Marcus Hook, Penn., refinery might best be used to illustrate procedure, because it was the largest single area included in the scrap drive, and yielded the greatest amount of scrap and salvage.

Facilities were surveyed by a team made up of the chief engineer of the manufacturing department, manager of refineries, superintendent of mechanical departments, chief refinery construction engineer, warehouse superintendent, and a number of assistants from the various divisions.

Nothing escaped their closest scrutiny.

Early in the Marcus Hook survey it became apparent that the scrap picture fell into three categories:

1. Definite scrap—that which could be scrapped without further consideration.
2. Possible scrap but dismantling costs might be prohibitive.
3. Still usable equipment; scrapping

cost high, operations must be changed—top management must decide whether the facility goes or stays.

With salvage and plant safety in mind, Sun decided to do its own scrapping rather than bring in outsiders. In this way, the company kept close control of still-usable materials, saving much scarce material difficult to purchase because of shortages.

Three crews razed obsolete installations and cut up scrap within the maximum limits of 2 x 2 x 6 feet—size required for an open hearth charging box. Burners, incidentally, used refinery propane gas in their torches.

Most of the scrap resulted from dismantling of obsolete refinery units, buildings, storage facilities and equipment.

Some of these outmoded units might have been permitted to linger in place or in use for another year or two if the company had not decided upon immediate action in response to the urgent appeal to help relieve the critical shortage of scrap.

Relatively little of the material condemned to the scrap piles was ordinary scrap of the type accumulated in day-to-day operations.

Here is a list, for instance, of salvaged material at the Marcus Hook refinery:

92 tons of serviceable steel pipe (4" to 10")
70 tons of structural steel shapes
63 tons of steel plate
111,000 board feet of lumber
14 electric motors
12 pumps
725 lineal feet of conveyors

Not properly classified as scrap, but certainly of value, were 10,000 cubic yards of rubble gained from demolition of two stacks and digging out foundations of various buildings that were razed.

This rubble was dumped along the Delaware River shoreline in front of the main office building and when fill dirt had been added and capped with black top, a new and badly-needed parking area 60 by 800 feet had been added—enough space for 160 automobiles.

One important lesson learned is that a well-conceived plant cleanup campaign can be made to pay for itself in actual dollars and cents and to yield many extra dividends, such as greater safety, better appearance and improved working conditions.

As for actual cash, Sun spent $134,700 at its Marcus Hook refinery in demolition of building, removing foundations and rubble, and preparing for the scrap market a total of about 3020 tons of metal. This scrap brought a credit of $105,500. Then, over and above this, the refinery salvaged the tons of usable steel pipe, plate, shapes and other materials.

Night View of Shell's New Detergent Plant at Petit-Couronne, France.

New French Detergent Plant Is Placed in Operation

E. N. TIRATSOO, London

THE official opening recently of the Shell "Teepol" plant at Petit-Couronne, near Rouen, represents a significant advance in France's petroleum chemical industry. With a designed capacity of 25,000 tons per year, it is one of the most modern detergent factories in Europe.

The raw material used for the detergent manufacture is a special wax fraction obtained during the refining of petroleum. The French installation utilizes the basic process in operation at the Shell refineries at Stanlow, in England, and at Pernis, in the Netherlands. Petit-Couronne, also an existing refinery center, was selected as the site of the first French plant, and Shell joined the Saint-Gobain chemical group to form a new company for the operation of joint chemical enterprises in France. Named Societe Shell Saint-Gobain, the new company is headed by M. Leon Kaplan (a director of Shell Francaise) as president and J. C. G. Boot as managing director. The Petit-Couronne installation, incorporating the results of British and Dutch experience, is their first concern, with an acetone plant at Berre also under construction.

The value of the detergent is two-fold: 1) as a replacement for soap, it serves to release more fats for use as foodstuffs at a time when these essential materials are scarce; and 2) it carries special detergent qualities in many cases superior to soap.

A powerful surface-active synthetic substance of the sodium alkyl sulfate type, the detergent is produced by cracking the wax feed stock and separating a special fraction of the olefin distillate thus obtained. This distillate is reacted first with sulfuric acid and then with caustic soda. After the unreacted material and by-products are removed, a concentrated solution of liquid detergent is obtained. One outstanding feature of the plant is the high degree of automatic operation, which enables a staff of only 70 to run the plant.

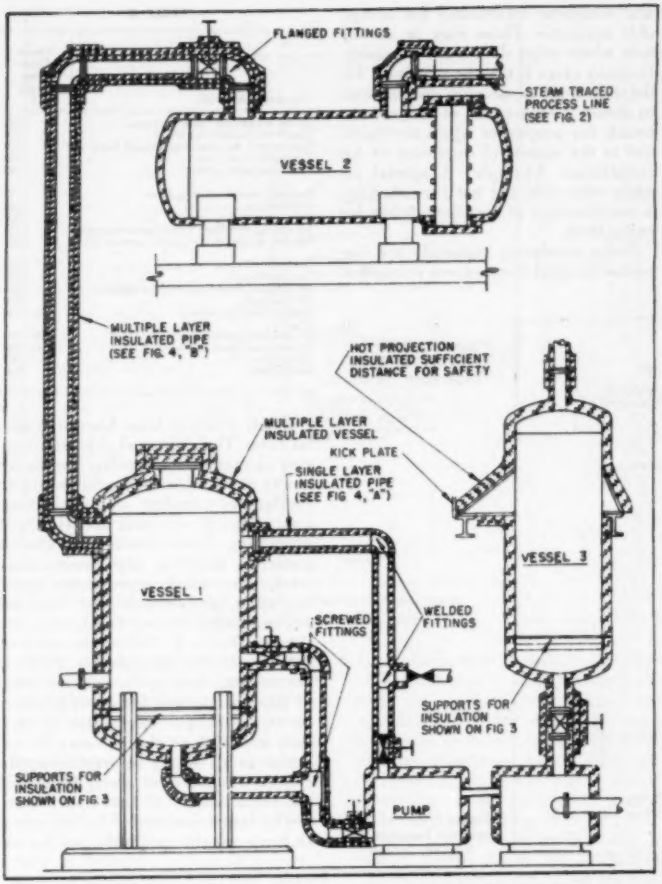

FLANGED FITTINGS
STEAM TRACED PROCESS LINE (SEE FIG. 2)
VESSEL 2
MULTIPLE LAYER INSULATED PIPE (SEE FIG. 4, "B")
HOT PROJECTION INSULATED SUFFICIENT DISTANCE FOR SAFETY
MULTIPLE LAYER INSULATED VESSEL
KICK PLATE
SINGLE LAYER INSULATED PIPE (SEE FIG 4, "A")
VESSEL 3
VESSEL 1
SCREWED FITTINGS
WELDED FITTINGS
SUPPORTS FOR INSULATION SHOWN ON FIG 3
SUPPORTS FOR INSULATION SHOWN ON FIG. 3
PUMP

Figure 1. Schematic Details of Typical Equipment, Pump and Piping, High-Temperature Insulation.

Thermal Insulation for Industrial Requirements

Part III—Specifications and Application of High Temperature Range Insulation

RAY THOMAS
Carbide and Carbon Chemicals Company,
South Charleston, W. Va.

THERE EXISTS no perfect insulation material that will satisfy all requirements of the design engineer; so the countless types and forms must each be evaluated in order to solve problems that arise in the processing industry. Such an evaluation should include a consideration of the thermal, physical, chemical and moisture conditions, as well as safety, economics, availability and time.

Part I and Part II of the series presented the basic and design considerations for high temperature range insulation. Part III links the engineering considerations with field application by a discussion of specification writing, insulation drawings, and maintenance.

THE first step toward good design of any thermal insulation installation is a careful consideration of the thermal, physical, chemical and electrical properties required. Following these considerations, the choice of material most nearly fulfilling those requirements may be made. It is then necessary to calculate the thickness which will provide the proper resistance to heat flow. Methods of application, from which can be determined the maximum strength, service, minimum cost and maintenance, must be decided upon; and finally, specifications must be written which will insure that proper materials be used and applied in the manner desired.

The specifications are the controlling link between engineering and field application. No matter how perfect the engineering design may be, weak specifications will result in a poor application of insulation in the field. Insulation specifications are generally divided into equipment specifications and piping specifications primarily because of the difference in form and application. Likewise, insulation specifications should be divided into the three fundamental temperature ranges. These temperature ranges are: 1) 212° F. and above, 2) 33 to 211° F. and 3) 32° F. and below. This article will concern itself mainly with the temperature range above 211° F.

Equipment material specifications should indicate the insulation material desired, describe its approximate chemical composition; and list its thermal, physical and electrical limits. Care must be taken not to designate a certain material and list properties not belonging to the material. On the surface such an error seems remote, but strangely enough it happens too frequently.

The form in which the material is to be furnished, such as straight or curved block, lagging or blanket, should be stated with allowable tolerances in dimensions including straightness and smoothness.

All insulating and finishing cements and accessories needed should be listed with their qualities noted. It is equally

important to specify the accessories as completely and accurately as the basic insulation material. The wrong strap, wire or other accessory, may be the cause of failure of the insulation installation, which is just as serious as a breakdown of the insulation itself.

One of the biggest drawbacks in the science of thermal insulation today is the lack of sufficient and comprehensive tests to evaluate the properties of thermal insulation materials. However, wherever possible, tests of the important properties should be determined and standards established for acceptable materials. These may be service tests where other data is not available. In many cases it may be necessary for the consumer to develop special tests to obtain a comparison of various materials for properties which are essential to the successful operation of his installation. Example: A special cement used with, but not furnished by, a manufacturer of the block or blanket being used.

Some insulating materials are furnished in rigid form, others in blanket, and still others in loose fiber or granular form. Their physical characteristics may or may not be similar. The writer knows of no table listing the available insulations complete with their thermal, chemical, physical and electrical properties. Some common insulating materials used for high temperature service, including approximate upper operating temperatures the material will withstand without breakdown, are listed in Table A. Neither the order of listing nor the temperature limit is any indication as to the relative value of these insulations for any particular set of conditions. As a matter of fact, each material on the list may be superior to all others for certain applications where it most nearly fulfills all the requirements of that application.

The limits established by the manufacturer should generally not be ex-

TABLE A

Insulating Material	Approx. Upper Temp. Limit °F
Layers of corrugated sheet asbestos	300
Glass fibres molded with binder	300
Carbonate of magnesia with asbestos fibers	600
Vermiculite with binder	600
Laminated asbestos felts	700
Processed amosite asbestos fibers	750
Cellular glass	900
Felted glass fibers	1000
Amosite asbestos fibers with diatomaceous earth	1200
Vitrified reinforced corrugated asbestos felt	1200
Felted mineral wool	1200
Calcium silicate	1200
Asbestos and compounds of silica magnesia	1200
Silica aerogel	1600
Mineral wool fiber cement	1200–1800
Mineral wool molded with binder	1600–1800
Diatomaceous earth and asbestos fibers	1500–1900
Silica fibers	2000
Kaolin fibers	2200

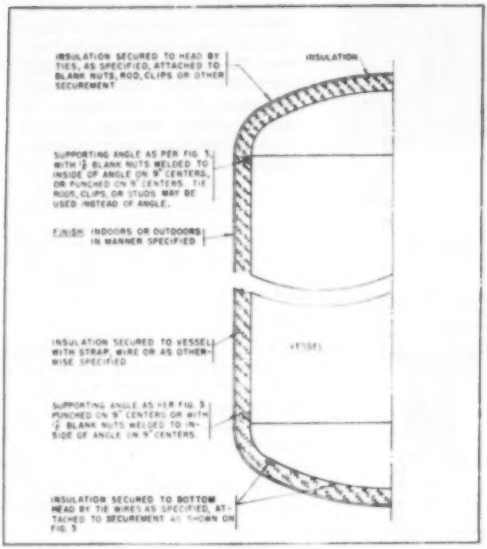
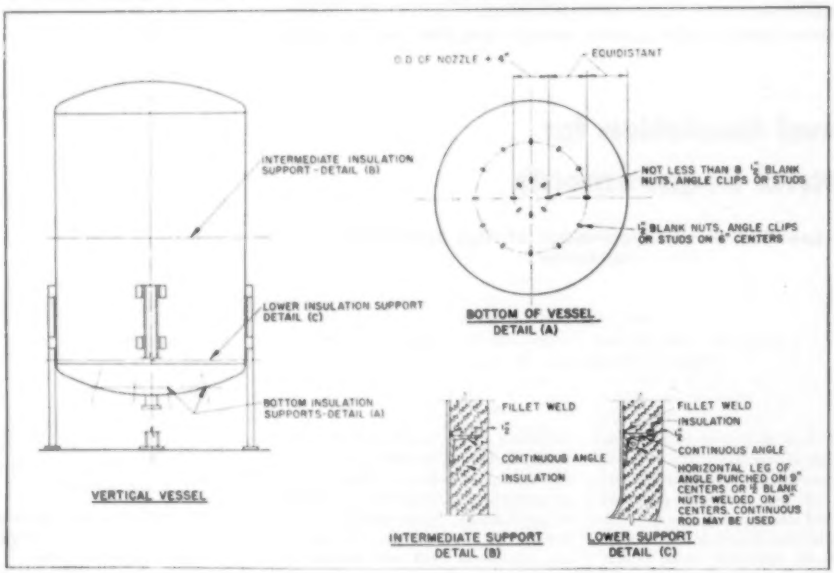
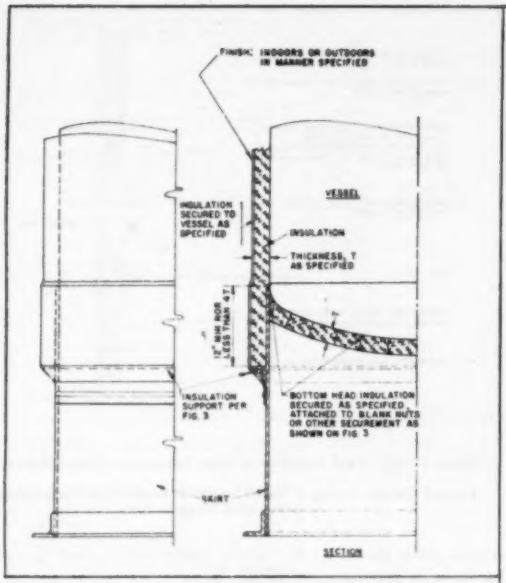

INSULATION SECURED TO HEAD BY TIES, AS SPECIFIED, ATTACHED TO BLANK NUTS, ROD, CLIPS OR OTHER SECUREMENT
INSULATION
SUPPORTING ANGLE AS PER FIG. 3 WITH ½ BLANK NUTS WELDED TO INSIDE OF ANGLE ON 9" CENTERS, OR PUNCHED ON 9" CENTERS. TIE RODS, CLIPS, OR STUDS MAY BE USED INSTEAD OF ANGLE.
FINISH: INDOORS OR OUTDOORS IN MANNER SPECIFIED
INSULATION SECURED TO VESSEL WITH STRAP, WIRE OR AS OTHERWISE SPECIFIED
VESSEL
SUPPORTING ANGLE AS PER FIG. 3 PUNCHED ON 9" CENTERS OR WITH ½ BLANK NUTS WELDED TO INSIDE OF ANGLE ON 9" CENTERS.
INSULATION SECURED TO BOTTOM HEAD BY TIE WIRES AS SPECIFIED, ATTACHED TO SECUREMENT AS SHOWN ON FIG. 3

Figure 2 (left). Insulation of High Temperature Vessel.

Figure 3 (below). Insulation Supports for Vertical Vessel.




FINISH: INDOORS OR OUTDOORS IN MANNER SPECIFIED
INSULATION SECURED TO VESSEL AS SPECIFIED
VESSEL
INSULATION
THICKNESS, T AS SPECIFIED
12" MIN. NOR LESS THAN 4T
INSULATION SUPPORT PER FIG. 3
BOTTOM HEAD INSULATION SECURED AS SPECIFIED, ATTACHED TO BLANK NUTS OR OTHER SECUREMENT AS SHOWN ON FIG. 3
SKIRT
SECTION

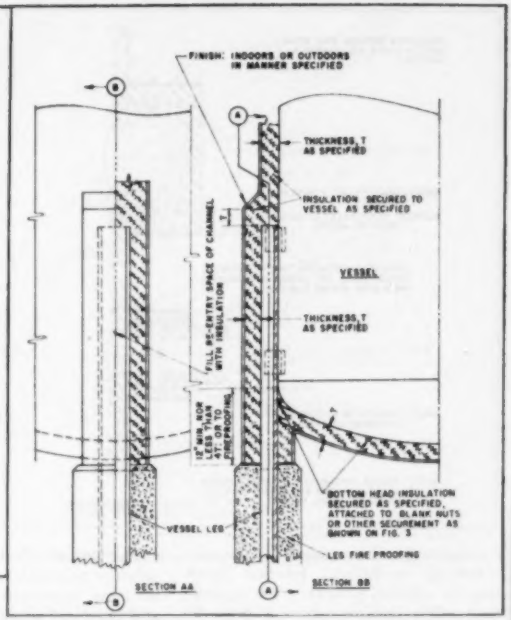

FINISH: INDOORS OR OUTDOORS IN MANNER SPECIFIED
THICKNESS, T AS SPECIFIED
INSULATION SECURED TO VESSEL AS SPECIFIED
VESSEL
THICKNESS, T AS SPECIFIED
FILL RE-ENTRY SPACE OF CHANNEL WITH INSULATION
12" MIN. NOR LESS THAN 4T OF FIREPROOFING
BOTTOM HEAD INSULATION SECURED AS SPECIFIED, ATTACHED TO BLANK NUTS OR OTHER SECUREMENT AS SHOWN ON FIG. 3
VESSEL LEG
LEG FIRE PROOFING
SECTION AA
SECTION BB

Figure 4 (above). Insulation of High Temperature Vessel Skirts.
Figure 5 (right). High Temperature Vessel Legs.

ceeded and then only when the user is willing to assume full responsibility for failure, should it occur. Following the selection of the proper insulation to be used, the next step will be the consideration of proper application, as required by the material.

The application specification should designate the types of support needed for the particular installation. Referring to Vessels 1 and 3 in Figure 1, each of these vertical tanks should have a support at the bottom to prevent the insulation from slipping. Additional details for the supports are shown for vertical vessels in Figure 3, for vessels equipped with skirts in Figure 4, and for legs in Figure 5. The specifications should state the manner of fitting the insulation and the means for securement. A very general drawing which may be adopted for numerous specifications is shown in Figure 2. This vessel is similar to Vessels 1 and 3 shown in Figure 1.

On cylindrical vessels blanket insulation may require other methods of attachment than the strapping as used with rigid insulation. It may be desirable to attach studs, rods, nuts or hairpin wires to the vessel surface for the purpose of securing tie wires; or, where suspended rods, angles or other attachment must be provided. These tie wires extend through the insulation and may be attached to expanded metal or hexagonal wire mesh over the insulation.

Where rigid material is applied to flat surfaces such as ducts, boiler walls, or flat heads of vessels, banding with strap or wire will not always secure it satisfactorily. On such applications it may be necessary to provide an additional attachment to the surface to be insulated. As in the case of blanket insulation, nuts, studs, and hairpin wires may be used for anchors for the tie wires. As a rule of thumb, using 12-inch staggered centers on the bottom, 18-inch staggered centers on the sides and 24-inch staggered centers on the top will place the anchors at proper distances to obtain a satisfactory attachment.

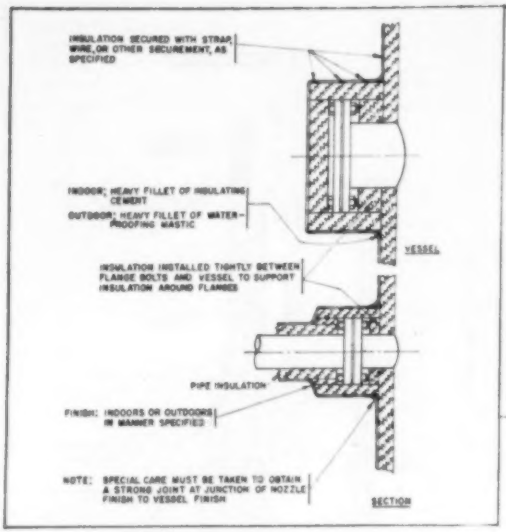
The insulation nozzles and blank flanges, where they extend through the insulation of a rigid insulated vessel, are shown in Figure 6. Most insulation failures begin at projections through the insulation, so it is quite important to obtain a tight secure application at these points. Most breaks of weatherproofing will be found at the inside corners of the junction of the vessel insulation with the pipe or nozzle insulation.

Vessel flanges are sometimes insulated and sometimes not, depending on operation and the possibility of flange leaks. On outdoor applications it is essential to weatherproof the ends of the insulation where stopped off at the nozzle or cut back to the vessel in cases where the flange is to be uninsulated. The weatherproofing is carried down over the ends of the insulation and sealed to the vessel. Caution must be used to specify a weatherproofing at this point which will withstand the highest temperature of the bare metal. This application is shown in Figure 7. A general method for applying rigid insulation to a vessel flange is shown in Figure 8.

Some equipment, particularly that with very irregular surfaces, may require the use of plastic insulating cements for a satisfactory application. When the surface to which the cement is applied is clean, the cement should be troweled in coats up to its required thickness. If the insulation exceeds 1½ inches in thickness it is well to reinforce its outer layer with 1-inch hexagonal wire netting or similar reinforcing. The netting should be completely embedded in the insulating cement so that it can not be seen on the outer surface.

Over most high temperature block or blanket installations a minimum thickness coat of insulating cement is troweled to fill any cracks or depressions and to obtain a smooth surface. If a paint finish is to be used over the cement it is well to reinforce the cement with hexagonal wire netting or similar material drawn taut over the block or blanket before the cement is applied. If the jacket is to be sheathing, metal or mastic coatings reinforced with glass cloth, or equal, the hexagonal wire netting reinforcement of the insulating cement may be eliminated.

The outer surfacing of insulated


INSULATION SECURED WITH STRAP, WIRE, OR OTHER SECUREMENT, AS SPECIFIED
INDOOR; HEAVY FILLET OF INSULATING CEMENT
OUTDOOR; HEAVY FILLET OF WATER-PROOFING MASTIC
VESSEL
INSULATION INSTALLED TIGHTLY BETWEEN FLANGE BOLTS AND VESSEL TO SUPPORT INSULATION AROUND FLANGES
PIPE INSULATION
FINISH; INDOORS OR OUTDOORS IN MANNER SPECIFIED
NOTE: SPECIAL CARE MUST BE TAKEN TO OBTAIN A STRONG JOINT AT JUNCTION OF NOZZLE FINISH TO VESSEL FINISH
SECTION

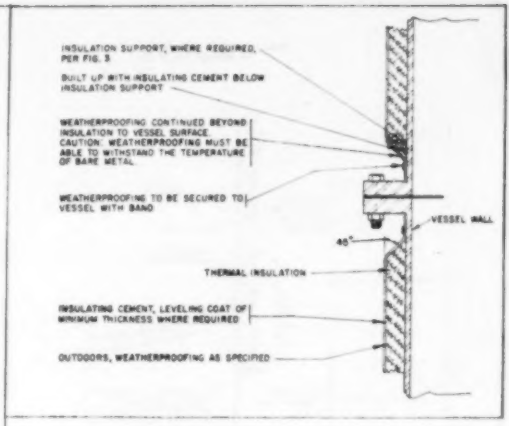

INSULATION SUPPORT, WHERE REQUIRED, PER FIG. 3
BUILT UP WITH INSULATING CEMENT BELOW INSULATION SUPPORT
WEATHERPROOFING CONTINUED BEYOND INSULATION TO VESSEL SURFACE CAUTION: WEATHERPROOFING MUST BE ABLE TO WITHSTAND THE TEMPERATURE OF BARE METAL
WEATHERPROOFING TO BE SECURED TO VESSEL WITH BAND
VESSEL WALL
45°
THERMAL INSULATION
INSULATING CEMENT, LEVELING COAT OF MINIMUM THICKNESS WHERE REQUIRED
OUTDOORS, WEATHERPROOFING AS SPECIFIED

Figure 6 (left). Rigid Insulation of High Temperature Vessel Nozzles.

Figure 7 (above). Sealing of Vessel Insulation Around High Temperature Uninsulated Flange.

equipment is determined by the surrounding conditions. Interior finish may be selected primarily for appearance while outside materials must be selected for their protection against the elements. Although semirigid jackets such as aluminum, steel, felt or mastic may be used inside, they are generally restricted to outside application where they not only serve as weatherproofing, but also withstand abuse much more effectively. Of course, an exception would be in order where the interior was extremely damp or subject to frequent washing. Rigid jackets may be used outdoors as well as indoors. Emulsified or cut-back asphalts are good outdoor finishes. Care should be taken in the choice of the proper bituminous coating as each compound has its own peculiar characteristics; and in the case of insulation, the one with the most desirable properties should be selected. A recent development is the use of vinyl plastic coatings for the protection of insulation. With the use of cut-back asphalts or vinyl plastic coatings it is good practice to use a suitable reinforcing such as glass cloth between the prime and finish coat. The high tensile strength of the reinforcement adds greatly to the toughness of the protective film. One precaution should be observed in the use of any vapor resistant coating; the insulation must be comparatively dry before application of the coating. If applied over wet insulation the vapor pressure developed by the heat from the vessel may be sufficient to cause blisters in the coating resulting in eventual fracture of the surface.

Piping specifications should, like equipment specifications, name the insulation material, describe it and list its most important thermal, physical and chemical properties. Likewise the insulation form, sizes, thicknesses and dimensional tolerances should be specified. All of the accessory materials should be noted and their important properties listed.

Molded pipe insulation should be applied with joints tightly butted. Suggested methods of attachment are shown in Figures 9, 10 and 11. Where temperatures are sufficiently elevated to warrant the use of insulation over 2 inches thick, multiple layers are often used to break the joints. When multiple layers are used and a different material is used for the inner layer than for the outer layer, care must be taken that the maximum temperature of the outer material is not exceeded on its inner surface. The thickness required for the inner and outer materials must each be scheduled to prevent errors in purchasing or field application.

Blanket type of pipe insulation is generally secured to pipe and fittings with wire, nettings or expanded metal mesh, over which is often applied a sheet metal jacket or insulating cement. In the selection of the proper blanket, both thermal and physical properties are important. Blankets made from fibrous base materials may vary considerably in their temperature limits because of the binder used in their makeup. In one case a fiber compounded with a resin type binder may be restricted to a limit of 550° F. although the fiber alone may be used at 1000° F. This same type of fiber may also be combined with a clay binder which will extend its use to 1800° F.

Fittings and valves, in lines of four-inch and over which are insulated with rigid formed pipe insulation, are usually insulated with block of the same material. After the blocks are fitted and secured in place with wire or strap, a coat of insulating cement is troweled over the surface. Blocks applied over flanges should extend over the adjoining pipe insulation for a minimum distance equal to the total insulation thickness and in no case less than 2 inches. Insulation on valves should always be stopped short of the packing glands so free access can be obtained for packing or tightening.

Finish or weatherproofing of the piping should be similar or at least equal to that of the adjacent insulated equipment. The method of application will be in a similar manner.

Insulation Equipment and Line Lists

Equipment and line lists of the insulation required should be provided for the contractor or field foreman to assist in the application and to prevent errors. These lists should provide the following information:

1) Name or identification of line or equipment to be insulated.
2) Location of equipment or lines.
3) Extent of insulation (parts uninsulated) and the area.
4) Length and size of line, number of fittings, flanges, valves.
5) Thickness of insulation.
6) The specification to be used in application.
7) Any special information not covered in the specifications.
8) Drawing numbers.

The specifications serve the purpose

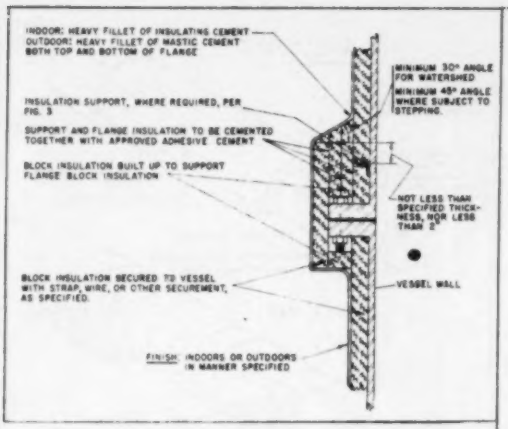

INDOOR: HEAVY FILLET OF INSULATING CEMENT
OUTDOOR: HEAVY FILLET OF MASTIC CEMENT
BOTH TOP AND BOTTOM OF FLANGE
INSULATION SUPPORT, WHERE REQUIRED, PER FIG. 3
SUPPORT AND FLANGE INSULATION TO BE CEMENTED TOGETHER WITH APPROVED ADHESIVE CEMENT
BLOCK INSULATION BUILT UP TO SUPPORT FLANGE BLOCK INSULATION
BLOCK INSULATION SECURED TO VESSEL WITH STRAP, WIRE, OR OTHER SECUREMENT, AS SPECIFIED.
FINISH INDOORS OR OUTDOORS IN MANNER SPECIFIED
MINIMUM 30° ANGLE FOR WATERSHED
MINIMUM 45° ANGLE WHERE SUBJECT TO STEPPING.
NOT LESS THAN SPECIFIED THICKNESS, NOR LESS THAN 2"
VESSEL WALL

Figure 8 (above). Rigid Insulation of High Temperature Vessel Flange.

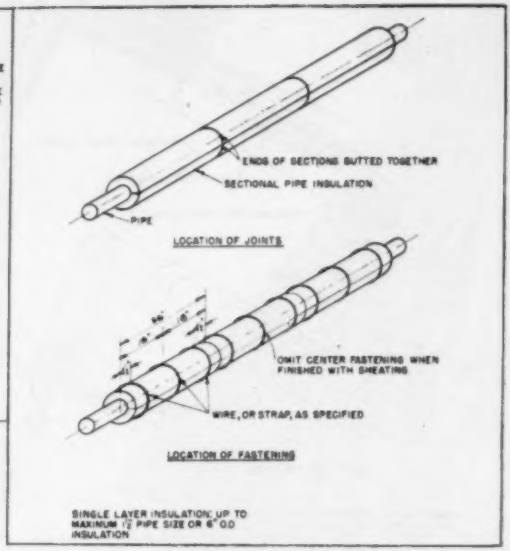

ENDS OF SECTIONS BUTTED TOGETHER
SECTIONAL PIPE INSULATION
PIPE
LOCATION OF JOINTS
OMIT CENTER FASTENING WHEN FINISHED WITH SHEATING
WIRE, OR STRAP, AS SPECIFIED
LOCATION OF FASTENING
SINGLE LAYER INSULATION UP TO MAXIMUM 12 PIPE SIZE OR 6" OD INSULATION

Figure 9. Securement of Single Layer Insulation to Small Pipe.

of describing the material and *how* the insulation is to be applied. The line and equipment lists tell what material is to be used and where it is to be installed.

There are two divisions of insulation drawings. One is used to illustrate details in the specifications and refer to no particular job installation. Illustrations, Figures 2 through 11 are typical of the use of these drawings. These drawings should be considered at the time of writing the specifications and are used only to assist the specifications in their function.

The other division of insulation drawings refers to the job in question. These drawings are used in conjunction with the line and equipment list to further amplify the extent and conditions of the insulation work. Without these drawings on a large installation it is extremely difficult to efficiently apply the insulation. References to the specifications on these drawings and specification detail drawings make it possible for the engineer to provide a method for his designs to be carried out by the field applicators. It is much easier to clearly show special construction details on drawings than it is by elaborate specification description.

Bills of Material

The bills of materials are the detailed answer to what insulation is to be used and the amounts needed. Bills of material should be prepared for each piece of equipment to be insulated and for each set of lines insulated under the same specification. The bills are used for several purposes—one, it is the basis for the purchase of materials; two, it serves as a guide for withdrawing materials from the storeroom to the field; three, it helps prevent application of the wrong materials.

In these days of scarce materials it is no small chore to locate, purchase and obtain delivery of all specified materials for an installation. In many instances it is even more difficult to obtain some of the accessory materials than it is the basic insulation materials. For this reason it is well to determine the availability of all accessories before being committed to a definite time erection schedule. In many cases it may be necessary to substitute material. It must be stressed that substitution of any material affects the design and any change, even of accessories, should be brought to the attention of the engineering department for their consideration. Substitution of the most insignificant accessory may completely alter the life of an otherwise good insulation installation. Substitution of basic insulation materials without due consideration by the engineering department can result in unsatisfactory operation, if not complete premature failure of the insulation application.

Field supervision is more important now than at any time in the past. Today we have a greater selection of insulations than heretofore and each should be applied in the manner most suited to its particular characteristics. Requirements are also becoming more and more difficult. For these reasons new uses of insulation methods of application are constantly being developed. The field supervisor must interpret the the design specifications and provide instruction in the proper application methods to obtain specified results. The field supervision requires coordination with the other crafts, the operating department and the engineering department to obtain fast and efficient field application. Good field supervision also requires a complete knowledge of stock on hand and expected delivery of materials not yet received. A common error of field supervisory personnel is permitting shortages of accessories to occur and delay the installation.

Field inspection of insulation is becoming more important as insulation application becomes more and more difficult. Proper inspection must begin at the start of every job, to be effective. Before any insulation is applied, the insulation inspector should examine the surfaces to be insulated to determine that they are prepared according to specification. Each step of application must be carefully watched to make sure that material used is as specified and is of desired quality. Tightness of fitting, method of supporting and strength of attachment must be scrutinized during the installation. The inspector must see that reinforcing, insulating cement and outer finishes are installed to conform to the specification. Of vital importance the inspector must make sure that weatherproofing is not installed over wet cement or insulation materials. The finished insulation must be carefully inspected as to appearance, tightness of joints, sealing of jackets or weatherproofing.

Substitution of materials should never be allowed by the inspection department without approval of the en-

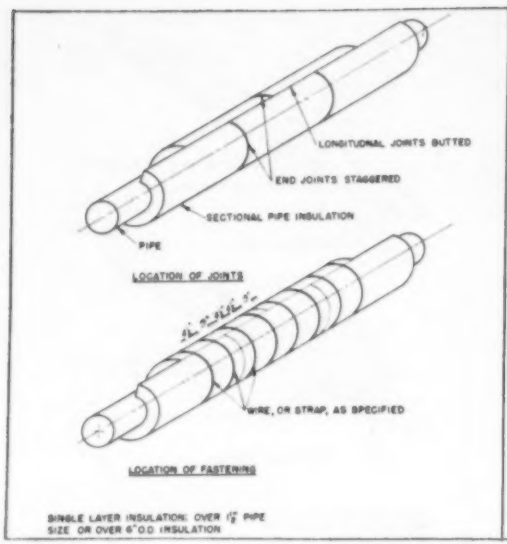

LONGITUDINAL JOINTS BUTTED
END JOINTS STAGGERED
SECTIONAL PIPE INSULATION
PIPE
LOCATION OF JOINTS
WIRE, OR STRAP, AS SPECIFIED
LOCATION OF FASTENING
SINGLE LAYER INSULATION: OVER 12" PIPE SIZE OR OVER 6" O.D. INSULATION

Figure 10. Securement of Single Layer Insulation to Large Pipe.

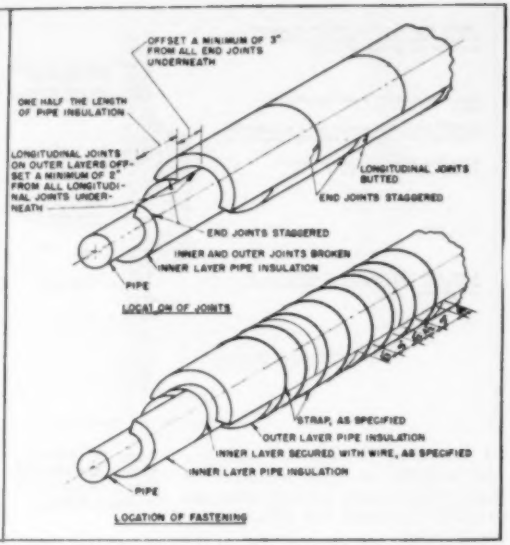

OFFSET A MINIMUM OF 3" FROM ALL END JOINTS UNDERNEATH
ONE HALF THE LENGTH OF PIPE INSULATION
LONGITUDINAL JOINTS ON OUTER LAYERS OFFSET A MINIMUM OF 3" FROM ALL LONGITUDINAL JOINTS UNDERNEATH
LONGITUDINAL JOINTS BUTTED
END JOINTS STAGGERED
END JOINTS STAGGERED
INNER AND OUTER JOINTS BROKEN
INNER LAYER PIPE INSULATION
PIPE
LOCATION OF JOINTS
STRAP, AS SPECIFIED
OUTER LAYER PIPE INSULATION
INNER LAYER SECURED WITH WIRE, AS SPECIFIED
INNER LAYER PIPE INSULATION
PIPE
LOCATION OF FASTENING

Figure 11. Securement of Multiple Layer Insulation to Pipe.

gineering department. The inspection department cannot be expected to know the reasons for the selection of each material for the various design conditions and thus must not be expected to make decisions which change the material or its basic application. When it becomes necessary to change materials or application in the field, the engineering department must be informed so that suitable corrections may be incorporated in the specifications and design of future installations.

Some formal method of acceptance should be practiced as a means of checking each piece of equipment and line. By this means details otherwise overlooked will be detected.

Maintenance

Adequate maintenance of the insulation in service is the major factor determining its economic life. Periodic maintenance inspection will uncover breaks in the surface, loose banding, fractures in weatherproofing and places where mechanical abuse has occurred. When these damaged spots are of a minor nature, repairs can be made at small cost, but if allowed to become progressively worse they will eventually cause complete breakdown of large areas to a point where it may become necessary to completely reinsulate a piece of equipment or line. In addition to the cost of replacement, the loss of heat during the breakdown period may be many times more costly than the insulation itself.

Correct insulation repairing is no small task. Maintenance insulation men must know how and where to patch up ruined insulation with as little loss to the surrounding good insulation as possible. They must be able to judge when insulation replacement is needed, or when new reinforcing, attachment or weatherproofing will suffice. There is no general answer as each condition is a problem of its own. Another difficulty encountered is the fact that most of their work must be done on and around equipment and piping in service. They must do their work without interrupting operation and still try to obtain a sound, tight, neat application.

Periodic maintenance inspection has an additional function, that of finding spots to be repaired. When such an inspection reveals an installation where the material has broken down or the application has not been satisfactory, it should be reported to the engineering department for their study so that corrective measures can be taken on future work.

Summary

To obtain the best insulation installation for the money invested the following points are of paramount importance:

1) The correct analysis of the requirements of the installation in question.

2) Consideration of all the characteristics of the available materials which might be used and the selection of the material most nearly fulfilling the needs.

3) A knowledge of the applicable calculation of heat transfer problems to arrive at a practical solution.

4) A sufficient knowledge of design to obtain a suitable application for the conditions and materials to be used.

5) Development of specifications to obtain the proper materials and application.

6) Preparation of insulation equipment and line lists and insulation drawings with complete information for the field.

7) Preparation of accurate and complete bills of materials to assist the purchasing department and field stores to obtain the proper materials when needed.

8) Efficient coordination with the purchasing department to obtain the right materials at the right price, or to let out contracts, as the case may be.

9) Intelligent and cooperative field supervision of the insulation installation.

10) Alert and careful inspection of insulation materials and their application.

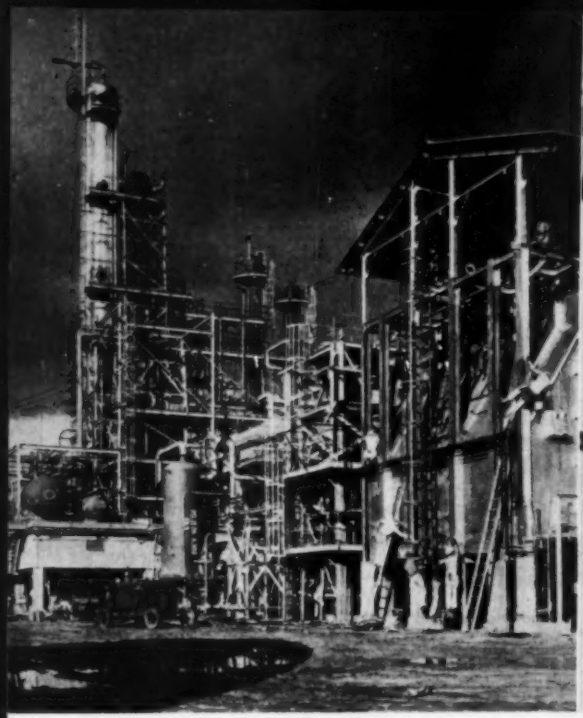
11) Adequate and periodic maintenance inspection.

12) Comprehensive maintenance of the insulation in service.

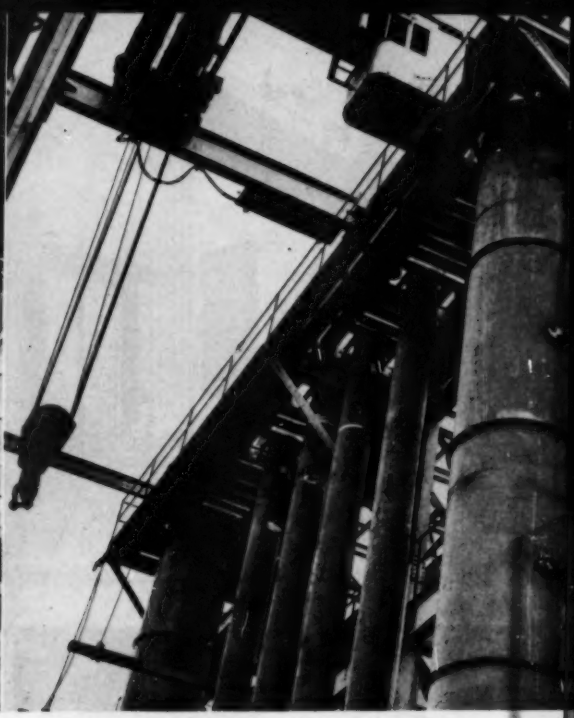
13) An understanding by the operating department as to the proper use and function of insulation.

14) Complete cooperation of all concerned.

End of Part III. Part IV will appear in an early issue.



Propane is cracked in the furnaces on the right. Propylene and ethylene so formed are separated in the columns in the background.



The heart of Texas Eastman's process is the high-pressure, catalytic reactors in which normal and isobutyraldehyde are formed.

Oxo Process Is Developed For Texas Eastman's Plant

THE completion of a new chemical plant on the outskirts of Longview, Texas, climaxes a program initiated in Tennessee Eastman Company's research and development laboratories in Kingsport, Tenn., some six years ago and represents a step toward self-sufficiency as far as the company's raw materials are concerned. The plant, operated by Texas Eastman Company, a division of Eastman Kodak Company, recently went into operation.

For many years Tennessee Eastman's principal raw materials have been cellulose and ethyl alcohol. Ethanol is converted to acetic acid, acetic anhydride, butyric acid and butyric anhydride. These acids and anhydrides, together with cellulose, are used in the manufacture of cellulose esters and other chemicals. The sale of these esters as such plus their use in acetate textile yarns and fibers, plastics and in the manufacture of safety film make them the company's principal product.

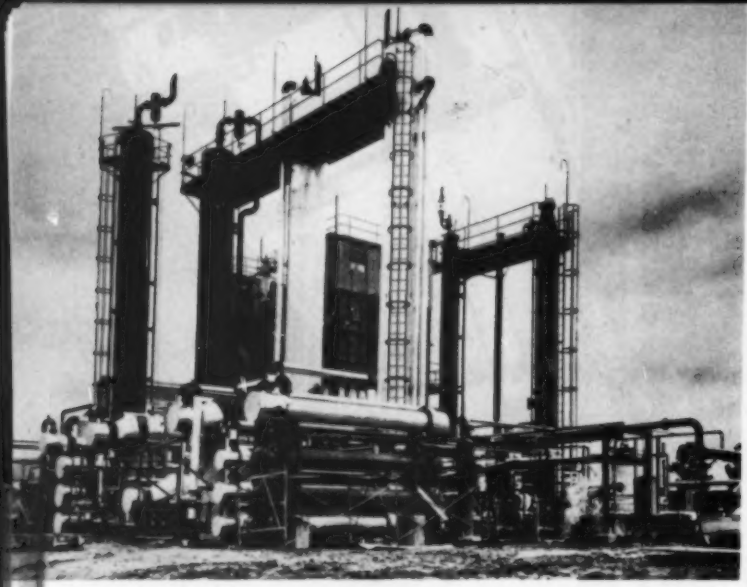
Two factors were uppermost in the minds of management in setting up Texas Eastman: 1) Tennessee Eastman's dependence upon ethanol; the unstable price of ethanol; and the potential shortage of this basic raw material; and 2) The long range outlook for butyric acid and for cellulose acetate butyrate and plastics which are dependent on butyric acid.

Concern over butyric acid set in motion the first development work in Kingsport. This work resulted in successfully combining a synthesis gas consisting of carbon monoxide and hydrogen with propylene under high pressure to form normal and iso butyraldehyde along the general principles of the German Oxo process. The conversion of the aldehydes to alcohols and acids is accomplished in well established processes.

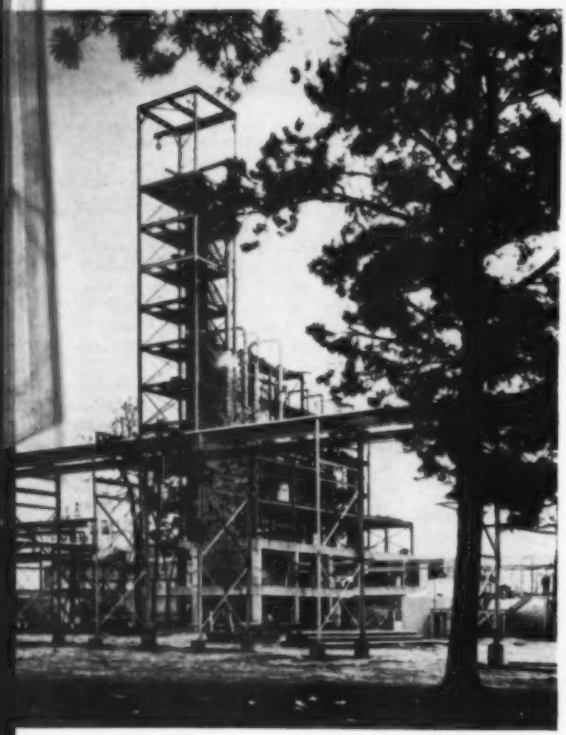
Thermal cracking of propane offered a source of propylene. Experiments convinced researchers that not only could they get their propylene by this process, but they could also get ethylene, which is a stepping stone to ethyl alcohol. Starting with propane, then, Tennessee Eastman could get acetic acid and acetic anhydride for their cellulose acetate, butyric acid and butyric anhydride for their mixed esters.

Two other raw materials necessary, carbon monoxide and hydrogen for the modified Oxo process, and hydrogen for the conversion of both of the aldehydes to their respective alcohols, result from a single reaction and equipment to accomplish this had already been developed by others. Carbon dioxide, natural gas and steam react at high temperatures to produce carbon monoxide and hydrogen. This reaction was ideal since abundant natural gas could be found in the same area as propane.

The most widely used process to con-



Above—Natural gas, carbon dioxide and steam react at high temperatures in these units to form synthesis gas.



Left—Crude iso and normal butyraldehyde mixture coming from the catalytic reactors is separated and refined in this distillation building. Part of the 2-ethylhexyl alcohol process is also carried out here.

vert ethylene into ethyl alcohol involves the use of sulfuric acid but the shortage of sulfur made this method impractical. So Eastman chemists in due time developed a route which did not require sulfuric acid. Thus the process development work had been successfully completed.

Of the many requisites for an ideal location, these were felt to be the most important—an economical supply of natural gas and propane in ample quantities, a suitable water supply, transportation, and particularly the labor supply. These ingredients were found in Longview in the northeastern part of Texas.

The Texas Eastman plant is located about five miles from Longview on the banks of the Sabine River in Harrison County, where a 300-acre lake has been created by erecting a dam across a small creek. This horseshoe-shaped lake measures about one and one-half miles around from tip to tip. Into one end of the lake river water is pumped as needed. Also into this end of the lake condenser water is discharged from the plant. Water for plant use is taken from the bottom of the other end of the lake. The lake thus provides a great settling and cooling basin which will be of particular importance in the summer months.

The major portion of the plant itself is located in the center of the horseshoe. The plant is built around the steam plant and the reactor building. At one end are the units where natural gas, carbon dioxide and steam are brought together and cracked at high temperatures to provide synthesis gas for the Oxo process and hydrogen for subsequent hydrogenation reactions. At the other end propane is cracked and propylene and ethylene separated.

The propylene and synthesis gas from these two operations are fed under high pressure into catalytic reactors where a mixture of n-butyraldehyde and isobutyraldehyde is formed. The aldehyde mixture from the reactors is then separated and refined.

Alcohol Units Last

The ethylene from the propane cracking units is sent to the alcohol plant where it is converted directly into ethyl alcohol. The alcohol units will be the last to get into production, and probably will not be ready until April, 1952.

The production of n-butyraldehyde will be split three ways, a portion to be sold as the aldehyde, a portion shipped to Kingsport, Tenn., where it will be converted to alcohol and acid for use in manufacturing cellulose acetate butyrate and Tenite plastic, and a portion converted to 2-ethyl hexyl alcohol for use in manufacturing dioctyl phthalate in Kingsport.

The isobutyraldehyde production will also be split three ways, one part will be available to industry as the aldehyde, another part will be converted to the alcohol, and a part will be converted to the acetate. Tests made in substituting the isobutyl alcohol and acetate in lacquer formulations currently using the n-butyl solvents show great promise.

The ethyl alcohol produced in Texas will be shipped to Kingsport for conversion into acetic acid, acetic anhydride and solvents such as ethyl acetate and isopropyl acetate.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the processing industry.

Joe J. King

R. V. Mertz

W. B. Cook

Paul R. Schultz

TGT Engineers Report On Extraction Plant

Both Houston residents, the authors of "Tennessee Gas Begins Operation of Refrigerated Extraction Plant" on page 118, are Joe J. King and R. V. Mertz.

King, born in Moody, Texas, is vice president of engineering for Tennessee Gas at present and has been a member of that staff since March, 1946, when he was accepted as assistant superintendent of compressor stations. Two years later, 1948, he was promoted to chief engineer, and became vice president in November, 1951. Previous experience included a stint as superitnendent of compressor stations for United Gas Pipeline Company, as a consulting engineer for The Texas Company, and service in the Office of the Chief of Engineers, United States Army, as Chief of the Petroleum Branch of War Plans Division.

He is a graduate in mechanical engineering from the University of Texas, and of the South Texas School of Law at Houston.

Oklahoma A. & M. Grad

Mertz, compressor superintendent for TGT, was born at Lake Arthur, N. M., graduated from Oklahoma A. & M. in electrical engineering and holds bachelor and master degrees in chemical engineering from the University of Oklahoma. He served as a junior engineer with Phillips Petroleum Company from 1930-35, and then became successively fractionator superintendent, chemical engineer, and superintendent of operations at Borger, Texas. From 1944 to 1946 he served as chief chemical engineer for the Mid-Continent Engineering Company at Dallas, and as mechanical engineer and group leader for Stanolind Oil and Gas Company from 1946 to 1950. At that time he joined TGT as a process engineer.

He Deals in Facts, Exposes Fiction

A native of the "Windy City," Paul R. Schultz, author of "Synthetic Liquid Fuels—Fact Not Fiction," on page 88, this month uncaps some of that "wind" and directs it at the straw house the Bureau of Mines has built up to create a synthetic-fuels-minded and bewildered public.

Currently manager of the economics department of Standolind Oil & Gas Company, Schultz joined the company in 1946 as chief chemical engineer. Prior to that he was employed by Standard Oil Company (Indiana) and located in his home town, Chicago. A member of the American Institute of Mining and Metallurgical Engineers, the API, ACS and Oklahoma and Texas Societies of Professional Engineers, he earned his B.S. degree from the Illinois Institute of Technology, and his M.S. degree in chemical engineering from Case School of Applied Science.

Dr. Matthews Named So-Vac Research Head

Dr. Frederic L. Matthews recently became technical director of the research section of Socony-Vacuum Oil Company laboratories at Paulsboro, N. J. He had been director of research of the Merrimac Division of Monsanto Chemical Company, Boston, since 1948.

Blueprints Refinery Painting Program

"How to Develop a Refinery Painting Program," as found on page 128, is the result of nearly 25 years observation and experience by W. B. Cook. Cook, specifically engaged in corrosion prevention work since 1946 as technical advisor on paint and painting practices at the Port Arthur, Texas, refinery owned by Gulf Oil Corporation, has been on the job at that refinery since graduation from Texas A. & M. College in 1927. A native Texan, Cook began his connections with the oil industry during his college days, working one summer in a pipe line pump station for Magnolia Pipe Line Company, and working the better part of a year in the Deepwater Refineries, Inc. laboratories prior to receiving his B.S. degree.

This is a return engagement to PR pages for Cook who published "Notes on a Refinery Paint Program" beginning in the February 1949 issue of this magazine. His employment with Gulf covers several years in the testing and experimental divisions of the Laboratory Department, as foreman, then assistant in the offices of the chief chemist, as assistant general superintendent, and general superintendent. During the war he served as security inspector of oil refineries and gasoline plants for the Southwest as an Army officer. Returning to Gulf he was assigned as advisor on paint and painting practices.

A home-owner in Port Arthur, Cook has opportunity to get in many "amateur licks" with a paintbrush in the maintenance of his property. Both Cook and his wife enjoy outdoor sports events and other social activities when time permits.

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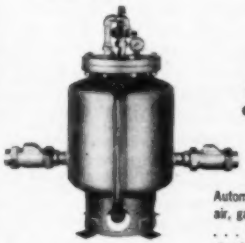

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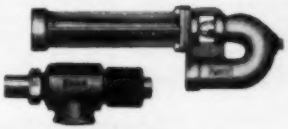

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Jack C. Dart | J. W. Schall | Kenneth A. Kobe | William G. Domask

Houdry Men Discuss Catalytic Cracking

The two authors of "Catalytic Cracking of High Nitrogen Charge Stock," page 101, are members of the Houdry Process Corporation staff. Jack C. Dart was very recently promoted to manager of research and development, and Josef W. Schall is known to PR readers through his contributions to this magazine, the latest being published last November.

Dart had been director of the Houdry development laboratory since 1947, being named to his new capacity last month. Prior to joining Houdry he served in various engineering capacities with Standard Oil Development Company, Magnolia Petroleum Company, Pan American Refining Corporation and Universal Oil Products Company. A member of the AIChE and the ACS, Dart received his B.S. and M.S. degrees at the University of Michigan.

Schall, born in Philadelphia, and a chemical engineering graduate of both Lehigh University and the University of Rochester joined Houdry in 1944 as a development engineer. Currently he is serving as section leader in Process Development. Before joining Houdry, Schall worked in the production department of Calvert Distilling Company as production planner and administrator.

Among his hobbies, engaged in at Springfield where he makes his home with his wife and two small sons, Schall enjoys various sporting activities, gardening, and duplicate bridge.

Kobe's New Co-Author Also Recent Father

The University of Texas campus furnishes the joint authors of a new two part series entitled "Extractive Crystallization" which starts on page 106.

Kenneth A. Kobe, graduate professor of chemical engineering, is familiar to all PR readers as the author of numerous articles, the most recent of which was a series on Thermochemistry which was concluded in the December issue.

At the present time Kobe is selecting a staff of three refinery engineers to go to Rio de Janeiro to teach in the graduate school which he set up last year at the request of the Conselho Nacional do Petroleo of Brazil. He organized the course to train Brazilian industrial chemists and chemical engineers for a career in government owned and operated refineries last August when he visited Rio, accompanied by his wife, to observe the educational facilities at the University of Brazil.

Most recent honor was that bestowed at Galveston when the South Texas section of the AIChE gave him the Publication Award for 1950 for a series based on methanol-lactic acid reaction which was written with Dr. R. A. Troupe. Kobe has published about 150 articles over a number of years. His latest books are, Inorganic Process Industries, published in 1948, and Chemical Engineering Reports, now in its third edition since publication in 1950.

Very active in teaching, research, publications, and technical societies, Kobe as chairman of the Chemical Engineering Education Projects Committee in 1950 initiated an industry-sponsored school with the slogan "Teach the Teachers." This program is now being conducted throughout the nation.

In spite of all this activity, he finds two nights a month to join Mrs. Kobe at their club square dance, and occasionall goes to a movie—providing the feature is "supplemented" with five or more cartoons. (Kobe reports a movie house in San Francisco that showed 15 cartoons continuously one evening almost broke up an A.C.S. lecture tour.) In addition to other activities, Kobe accepted an appointment as lieutenant colonel in the U. S. Air Force Reserve, Research and Development Section, in 1950. The armed forces being the armed forces, he is now commanding officer of the 9814 VART Squadron and attends regularly to "accumulating points toward retirement" which his wife says he will never live to enjoy if he doesn't stay home more.

Proud new papa is **William G. Domask,** a post graduate student working toward his Ph.D. degree under Dr. Kobe. His problem is concerned with a study of the mechanism of the reaction for the formation of ethylene chlorohydrin from ethylene, chlorine and water. For the past two years Domask has held the Jefferson Chemical Company graduate fellowship and has found time to serve as president of Phi Lambda Upsilon and Omega Chi Epsilon.

Sharing his busy school life is his lovely wife, Mary Margaret Gunter, who holds business and law degrees from the University and who has had several years experience as a practicing lawyer. Until recently Mary Margaret worked as research librarian at the law library.

Domask, a native Texan, holds B.S. and M.S. degrees in chemical engineering from Texas A. & M. College as well as a reserve commission in the Chemical Warfare Service. During the European campaign he received the Bronze star for the formulation of the logistical plan for gas defense which was adopted for the early phases of the invasion. After the war he started work at the Jefferson Chemical Company research laboratories in Port Arthur. Other industrial experience includes three summer vacations working for the Gulf Oil Corporation in Port Arthur, two summers assigned to the testing lab and one summer in the pipe department.

Pei Moo Ku Joins Staff Of Bureau of Standards

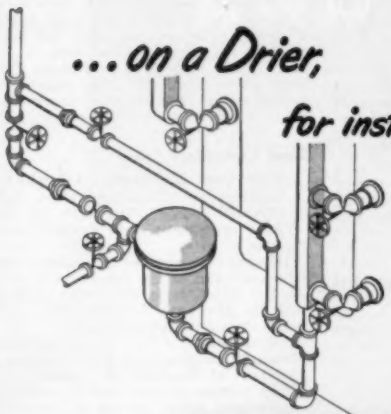
Pei Moo Ku, formerly an assistant professor at the Massachusetts Institute of Technology, has joined the staff of the Engines and Lubrication Section of the National Bureau of Standards.

Ku specialized in internal combustion engines at M.I.T. and has published a number of papers describing his researches in this field. In 1948 he was professor of aeronautical engineering at Tsinghua University, China.

Ku received a B.S. in electrical engineering from Chiao-Tung University, Shanghai, China in 1935 and a D.I.C. in aeronautical engineering from the Imperial College, London, England in 1939.

Example of Steam Trap Durability

...on a Drier, for instance



THE INSTALLATION

On heavy-duty, steam-heated tumbler-type drier at American Linen Supply Company, Cincinnati.

THE HISTORY

A high discharge capacity trap was needed to operate this drier 16 hours daily under heavy loads, with 125 psi. steam. Specifications called for rapid, fully automatic condensate removal to insure fast warm-ups and a steady flow of hot, dry steam to the drier. Naturally, the lowest possible trap maintenance cost was also wanted.

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PRICE:	Good Buy
AVAILABILITY:	Stock item in Crane line

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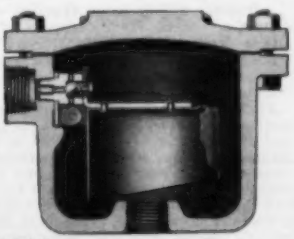

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BOOKS of Current Interest

Review and Comment for the Process Man

Mechanics of Flow in Pipes

Fluid Flow In Pipes, Clifford McClain, The Industrial Press, 148 Lafayette St., New York 13. $3.

For engineers or students, "Fluid Flow in Pipes" is an ideal introduction or refresher covering the mechanics and dimensions of gas and liquid flow in pipes and ducts. The fundamental physical processes involved are explained in simple language, and the dimensions used in various systems of calculation are clarified.

The properties of fluids affecting flow are discussed with illustrations of the over-all influence of each. Theory, measurement and dimensions of viscosity, with particular attention to relationships between various methods of measurement, are carefully explained for the beginner, while derivation calculations are included for those who wish to explore the subject more deeply. Friction and energy balance problems involving turbulence and streamline flow are solved with emphasis upon consistency in the evaluation of such factors as the Reynolds number. Empirical formulas used in flow calculations are presented with a discussion of the physical basis for such formulas.

Treating Water Impurities

Water Treatment for Industrial and Other Uses, Eskel Nordell, Reinhold Publishing Corporation, 330 West 42nd Street, New York. $12.

Cited as an exhaustive, practical and up-to-date reference work on the conditioning and treatment of water supplies for industrial and domestic uses, this volume deals with water impurities and the methods of treatment to fit water for a great variety of commercial and other uses. The material is stated clearly and simply so that basic principles involved and the solutions to specific problems should prove of value to executives, consultants, engineers, chemists, operating personnel and students.

Extensive tables of conversion factors and equivalents and other valuable tabular data contribute to the completeness of this presentation.

Aviation Gasoline Research

Bulletin 497, Aviation Gasoline and Its Component Hydrocarbons: Wartime Research (1940-1945), Superintendent of Documents, United States Government Printing Office, Washington 25. $1.50 per copy.

The aviation gasoline program, begun more than a year before Pearl Harbor, was the most important phase of the Bureau of Mines' studies on petroleum chemistry and refining during the war period. The research is described briefly and the more important data, developed more fully. Equipment, procedures, evaluations of test data and other graphic material is presented in full.

Basic Fuel Requirements

Mechanical Octane Numbers, Earl Bartholomew, Ethyl Corporation, 100 Park Avenue, New York 17. Free upon request.

This publication is a report on the progress made by both the automotive and the oil industries during the past 25 years. Following a definition of mechanical octane numbers, the brochure compares the performance of a 1950 engine of advanced design with that of a 1939 production engine using a typical 1939 fuel. Both engines were making the best utilization of the 1939 fuel that their design permitted. Here it is shown that the mechanical octane numbers designed into the 1950 engine provide gains of 10 percent in performance and economy without requiring higher octane-number fuel.

Ethyl research in developing future mechanical octane numbers is shown to be directed toward basic research on fuel utilization and engine design.

Lube Oil Efficiency

Properties of Lubricating Oils and Engine Deposits, C. A. Bouman. The MacMillan Company, 60 Fifth Avenue, New York 11. $3.50.

Containing much authoritative information on the efficiency of lubricating oils in diesel and gasoline engines, this useful review of the principles and problems of lubricating oils contains the following:

Causes of various types of deposits are discussed and the effects of fuel combustion on lubricating oils and the relationship to engine fouling of such factors as temperature, load, and speed is analyzed. Oil ratings, viscosity indexes, and other data is explained as well as the effect of dopes added to oils.

Data from extensive tests made in the Delft Laboratory of the Royal Dutch Shell group, and from the work of leading investigators in many countries, are included.

Engine Antifreeze Tests

ASTM Standards on Engine Antifreezes, ASTM Committee D-15, American Society for Testing Materials, 1916 Race St., Philadelphia 3. $1.

The first edition of this manual was just recently issued and was compiled in order to make a convenient compact form of the information available throughout the industry. Methods included cover sampling and preparing aqueous solutions of engine antifreezes; freezing point of solutions; physical tests for boiling point of engine antifreezes, and specific gravity of concentrated antifreezes by the hydrometer; chemical tests for ash content and reserve alkalinity of concentrated engine antifreezes, and for water in concentrated engine antifreeze by the iodine reagent method.

Survey of Energy Sources and Resources

Energy Sources, The Wealth of the World, Eugene Ayres and Charles A. Scarlott, McGraw-Hill Book Company, Inc., New York. $5.

Here is an analysis of the problem concerning the duration of existing fuel supplies, including a census of our energy sources, past, present, and future. The history of man's efforts to wrest energy from nature is given, as is also a detailed review of the size of energy resources, technology of production, efficiency of conversion, and progress being made in conservation. Presenting statistics not readily available elsewhere, the authors tell much about all types of energy sources and what we may expect from them in the future.

A chapter presenting an Energy Balance Sheet concludes this significant survey of an indispensable element of man's welfare and wealth—energy.

Steel Technology Study

Tool Steel Handbook, Allegheny Ludlum Steel Corporation, 2020 Oliver Building, Pittsburgh 22, Pa. Free upon request to qualified persons.

Designed for engineers, teachers, metallurgists and others interested in tool, die and allied steels, this latest publication by Allegheny Ludlum Steel Corporation is intended as companion literature to "Stainless Steel Handbook" and "Strength of Stainless Steel Structural Members as Function of Design."

The volume on tool steels begins with charts and tables giving specific and comparative data on properties, analyses and applications. This is followed by detailed descriptions of all important grades of tool steel, forms and finishes of tool and die steels, and extensive discussions of heat treating and handling techniques.

Tank Car Load Code

Tentative Code for Pressure Tank Car Quantities or Code for Calibrating Tank Car Tanks and for Measuring, Sampling and Calculating Tank Car Quantities (Pressure Type), American Petroleum Institute, 50 West 50 Street, New York 20. $1.

This Code was prepared through the cooperation of a large number of companies and under the supervision of the Committee on Tank Car Quantities of the API Division of Transportation. Part I deals with measuring, sampling and calculating pressure tank car quantities and Part II sets forth a procedure for calibrating pressure type tank car tanks. It is identified as Code No. 1202.

Heat Transfer Analysis

Industrial Heat Transfer, F. W. Hutchinson, The Industrial Press, 148 Lafayette Street, New York 13. $6.

Solution of problems on heat transfer between industrial fluids involves the solution of complex formulas as well as time-consuming determination of viscosity, specific heat, and density of the fluids. "Industrial Heat Transfer" was written to simplify this problem, and presents 128 working charts from which a direct solution of heat transfer problems can be obtained for 70 industrial fluids from air and acetylene to sulfur dioxide and water. The graphs are equal in accuracy to the equations

McKee builds the plants that produce them

IT'S virtually impossible to find a place where steel is used without the use of some petroleum product in its production, fabrication or operation. It is just as hard to name a use for gasoline or oil without steel in the picture.

Steel and Oil—these are industry's "inseparables" and they are needed today in greater quantities than ever before.

The McKee organization has designed and built hundreds of plants in the United States and some 25 foreign countries and is now engineering new facilities which will account for a definite increase in the production of iron and steel and petroleum products.

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- ☐ Low maintenance costs
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- ☐ Proved reputation of maker
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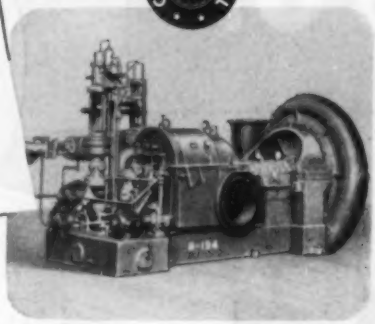

Type OIB Gas Exhauster, driven by steam turbine. Capacity 19,000 cfm.

You can't afford to take chances when production and profits depend on maintained performance of blowers, exhausters, gas pumps or related equipment. So, we suggest that you check carefully the above factors before you make your final decision.

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We'd like to remind you, too, that for almost a century we've built only blowers and related equipment. Our products have a long, happy record for outstanding, reliable, economical performance. Our vast reservoir of engineering experience is always at your service, to meet almost every industrial problem of moving gas or air.

ROOTS-CONNERSVILLE BLOWER CORPORATION
523 Crescent Avenue, Connersville, Indiana

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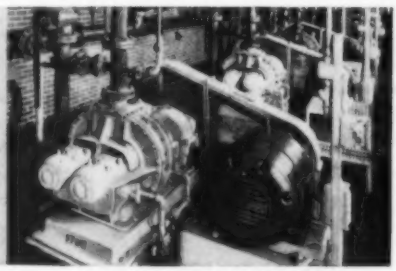

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Books

from which they are derived. The page opposite each graph gives the equation for the graph, its limitations, extensions, and references to the discussion of that equation in the text.

Haensel, UOP, Receives Precision Scientific Award

Vladimir Haensel, a member of the Universal Oil Products staff, is the 1952 recipient of the Precision Scientific Company Award in Petroleum Chemistry. Recognized for his work in developing more economical and efficient utilization of petroleum as a raw material, Haensel more than any other, was credited with the development of the Platforming process. During the war he developed a practical demethylation process for producing triptane.

Haensel was schooled in Germany, Austria, Russia, and at the age of 17 entered Northwestern University to study engineering, working summers under V. N. Ipatieff in the UOP high pressure laboratories. He accepted a chemical engineering scholarship to Massachusetts Institute of Technology and in 1937 received his M.S. degree, going on to his Ph.D. under Ipatieff at Northwestern. Since 1941 he has been working at UOP, perfecting a number of patents and writing a long list of technical articles. In 1945 he was named to his present position as coordinator of the cracking research division.

Chapman Commends Industry On Scrap Drive Results

Oscar Chapman, secretary of the Interior, has praised the oil industry for the "significant" contributions made to the steel and metal scrap drive. Sun Oil Company during the past six months contributed 8000 tons of steel, plus 140,000 pounds of copper and brass; the American Gas Association, 45,100 tons plus 16,000 tons of iron; The California oil industry special committee on steel scrap contributed 38,000 tons; Sinclair Refining Company expected to show over 80,000 tons this year to compare with 50,000 last year; Esso, 15,000 tons; Standard Oil Company of California, 14,000 tons; Standard Oil Company (Indiana), 10,000 tons; Atlantic Refining Company, 4000 tons; Pan American Refining, 1500 tons from Texas City operation; Richfield Oil Corporation, 915 tons. Other totals are not available.

Phillips Chemical Plant, Borger, Wins Safety Award

Employes of Phillips Chemical Company's Philblack plant at Borger, Texas, have completed their second consecutive year without a lost-time accident, a safety record, representing a total of 884 consecutive days for the 335 employes. The plant has received both the National Safety Council's distinguished award for its perfect record in the Chemical Section Contest sponsored by the Council in 1950, and the Joseph A. Holmes Safety Award presented at the completion of the first one million man-hour record in the plant's history. A. J. Head is plant superintendent and J. W. Logan is safety supervisor.

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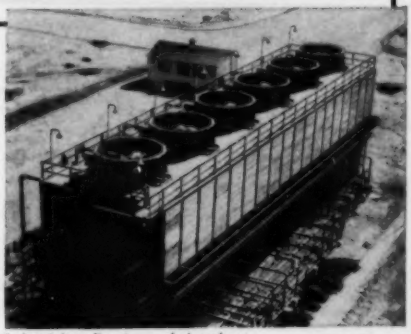
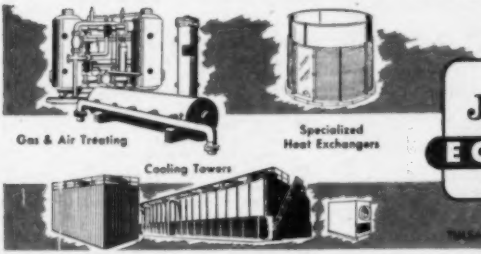


Industrial cooling tower designed, engineered and constructed by J. F. Pritchard & Co.



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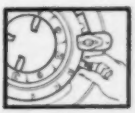

Dies Easily Removed from Outside

• The new Beaver 26-R is a greatly improved and simplified successor to the "old Beaver 26," popular for 40 years. Drive ring is on top—in line with dies for easy cutting. Oversize, undersize or standard threads can be cut of uniform length. Has "radio dial" setting. Change size in 2 seconds without tools. Standard taper or electric conduit threads. One set dies. No bushings.

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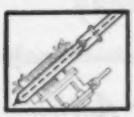

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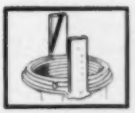
Universal Chuck • Accurate Centering • No Bushings



Cuts Taper or Straight Threads

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FOR MOIST OR CORROSIVE ATMOSPHERES

Killark Alumalloy Vapor-Tight Lighting Fixtures are absolutely vapor-tight and weatherproof and will never rust. Reflectors —available in standard dome, shallow bowl or angle styles—designed to meet any lighting need. Typical outdoor installations include docks, loading platforms, railroad yards, underpasses, bridges, etc. Indoor locations range from cold storage plants, breweries and dairies, to electro-plating plants and other corrosive chemical atmospheres. Sizes: 60W, 100W, 150W, 200W, 300W, 500W.

Killark — Write for Illustrated Bulletin

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FOR *More Information* ON PRODUCTS ADVERTISED

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New Catalogs AND EQUIPMENT LITERATURE

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Tank Roof Designs

A booklet describing expansion roof tanks for conservation of petroleum products is announced by Graver Tank & Manufacturing Company, Inc. Single and multiple tank installations, service records of equipment, underwriters reports, etc., are included in the material.

Circle No. 1 on Postcard

Valves Process Plant

"W-K-M Process Plant Valves" is the latest folder by the W-K-M Company describing construction, operation and specification of various items of their line.

Circle No. 2 on Postcard

Fans and Blowers

Standard Electric Manufacturing Company offers a catalog containing material on a wide range of fans and blowers. Rubber mountings and lifetime lubrication are two of the features of this line.

Circle No. 3 on Postcard

Radiamatic Pyrometer

The Brown line of Radiamatic pyrometers is described in Minneapolis-Honeywell Regulator Company's new catalog. Operation, theory, constructional features, are among section headings.

Circle No. 4 on Postcard

Steel Identification Chart

Identification of various stainless steel types is said to be speeded up through use of The Carpenter Steel Company, Alloy Tube Division, new revised Segregation Chart. The tests given do not supplant chemical analysis, but provide handy and quick methods for segregation if the operator has some technical knowledge of alloys.

Circle No. 5 on Postcard

Standby Power

Featured in "E-M Synchronizer," No. 35, quarterly publication of the Electric Machinery Manufacturing Company, is an article on standby or emergency power. The feature deals with requirements of standby power, types of service available, and a detailed discussion of controls for automatic start-stop operation.

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New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Rotary Pumps

A bulletin describing the new De Laval A 313B IMO rotary pump, is now available from De Laval Steam Turbine Company. A general service screw-type rotary pump designed for handling petroleum products and other light viscous fluids, it has a capacity to 80 gpm, with pressures to 275 psi. (continuous), and 325 psi. (intermittent). Main features of the pump include pulsation free flow, mechanical shaft seals, pre-lubricated bearings, and optional types of mountings.

Circle No. 7 on Postcard

Floor Coatings

Industrial floor problems are analyzed and suggestions given for providing a walkway surface offering high resistance to slipping, in a bulletin published by The Wilbur & Williams Company. Among other floor treatments described is the Rubber Coat Skid Grip Floor Compound which is easily brushed onto wood, concrete or mastic floors.

Circle No. 8 on Postcard

Butterfly Valve

Use of Minneapolis-Honeywell Regulator Company's Air-O-Motor diaphragm operators with continental butterfly valves is described in a new specification sheet.

Circle No. 9 on Postcard

Aluminum Stearates

American Cyanamid Company's Industrial Chemicals Division has published a booklet for manufacturers of lubricating greases, describing three new grades of Cyanamid Aluminum Stearates. Gelling strengths and other data are included.

Circle No. 10 on Postcard

Flow-rate Meter

A folder describing Fischer & Porter Company's Stock Flow Meter Program for immediate shipment of its Predictable metering floats for "area" flow-rate meters is announced. Specifications, capacities, sizes and other data is given.

Circle No. 11 on Postcard

Pressure Controller

A non-indicating pressure controller, Honeywell Pressure Pilot, is described in a Minneapolis-Honeywell Regulator Company bulletin.

Circle No. 12 on Postcard

Fractional Distillation

The Podbielniak apparatus with multi-range ElectroniK potentiometer for high temperature frequency distillation studies is described in a Minneapolis-Honeywell Regulator Company Data Sheet.

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(More Literature Items on Pages 161, 163, 167, 169)

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A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	P2	Q2	R2	S2	T2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	P3	Q3	R3	S3	T3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	P4	Q4	R4	S4	T4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	P5	Q5	R5	S5	T5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	P6	Q6	R6	S6	T6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	P7	Q7	R7	S7	T7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	P8	Q8	R8	S8	T8
A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	P9	Q9	R9	S9	T9
A10	B10	C10	D10	E10	F10	G10	H10	J10	K10	L10	M10	N10	P10	Q10	R10	S10	T10

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Aromatic Hydrocarbon Detector

A portable, compact, light-weight aromatic hydrocarbon detector is described in a new bulletin by Mine Safety Appliances Company. The maximum allowable concentrations for eight-hour per day exposure to benzene in the air is 35 ppm, and for toluene or xylene 200 ppm, in specifications set by the American Conference of Government Hygienists in 1950. The instrument provides for separate graduations for benzene, toluene and xylene, on the cylindrical scale; detector stain increase in direct relation to aromatic concentration; fast, simple operation; compactness of design, and ease of use.

Circle No. 14 on Postcard

Electronic-Optical System

The theory behind three important methods of analysis: colorimetry, fluorometry and nephelometry, are explained in "The Nefluoro-Photometer," a booklet recently released by Fisher Scientific Company. The Nefluoro-Photometer gives rapid readings for a variety of organic, inorganic, synthetic and biological materials.

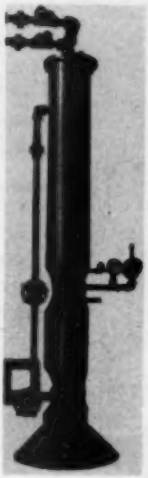
Circle No. 15 on Postcard

Infrared Spectrophotometer

This Minneapolis-Honeywell Regulator Company Data Sheet describes the Beckman Model IR-2 and IR-2T spectrophotometer as used with the Brown ElectroniK recorder and also the direct transmittancy recording attachment for the Model IR-2 infrared spectrophotometer.

Circle No. 16 on Postcard

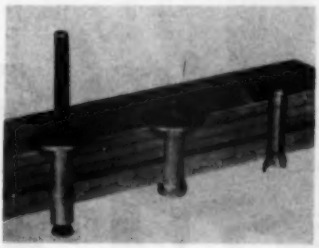
Acid Pump



A new acid pump which contains no working parts has been developed by Instruments, Incorporated. The pump, known as Merc-O-Pump, gives constant, positive action employing a column of mercury as the liquid mover. Operating costs and downtime are reduced, according to the manufacturer. Operated on air or steam, it has a rate of 3 to 30 gallons per hour, with the rate variable over the entire range by application of external adjustment. A new bulletin furnishes cost, application, specifications and other pertinent data.

Circle No. 17 on Postcard

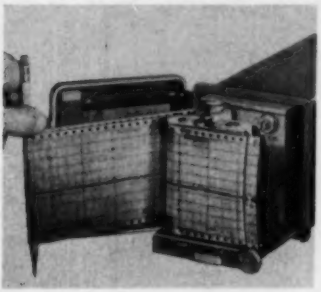
Blind Rivet



Blind rivets which provide increased bearing area when fastening thin or soft materials to metal frameworks have been added to the Huck Manufacturing Company line of products. The rivets are used for foil, plywood linings or floors, Masonite or Bristol Board panels, insulation, etc. Installation is made by one person from one side of the work. The blind rivets are available in both aluminum and steel in either the R949 (Pull through) or R974 (Self plugging) types in various diameters. The photo shows the rivet before and after driving.

Circle No. 18 on Postcard

Miniature Chart Recorder



A new independently powered miniature strip chart recorder with an electronically actuated pen is announced by the Swartwout Company. Known as the Autronic Recorder, it is the graphic indicator for the new Control System developed for use in chemical and refineries, petrochemical installations, etc. It is an electronic servo-powered null-balance device creating a highly accurate and instantaneous record of the measured variable. Unbalance between the output of the primary element transmitter and the balancing transformer is amplified to drive the powerful rotary-solenoid motor for positioning the pen.

Circle No. 19 on Postcard

Laboratory Instruments

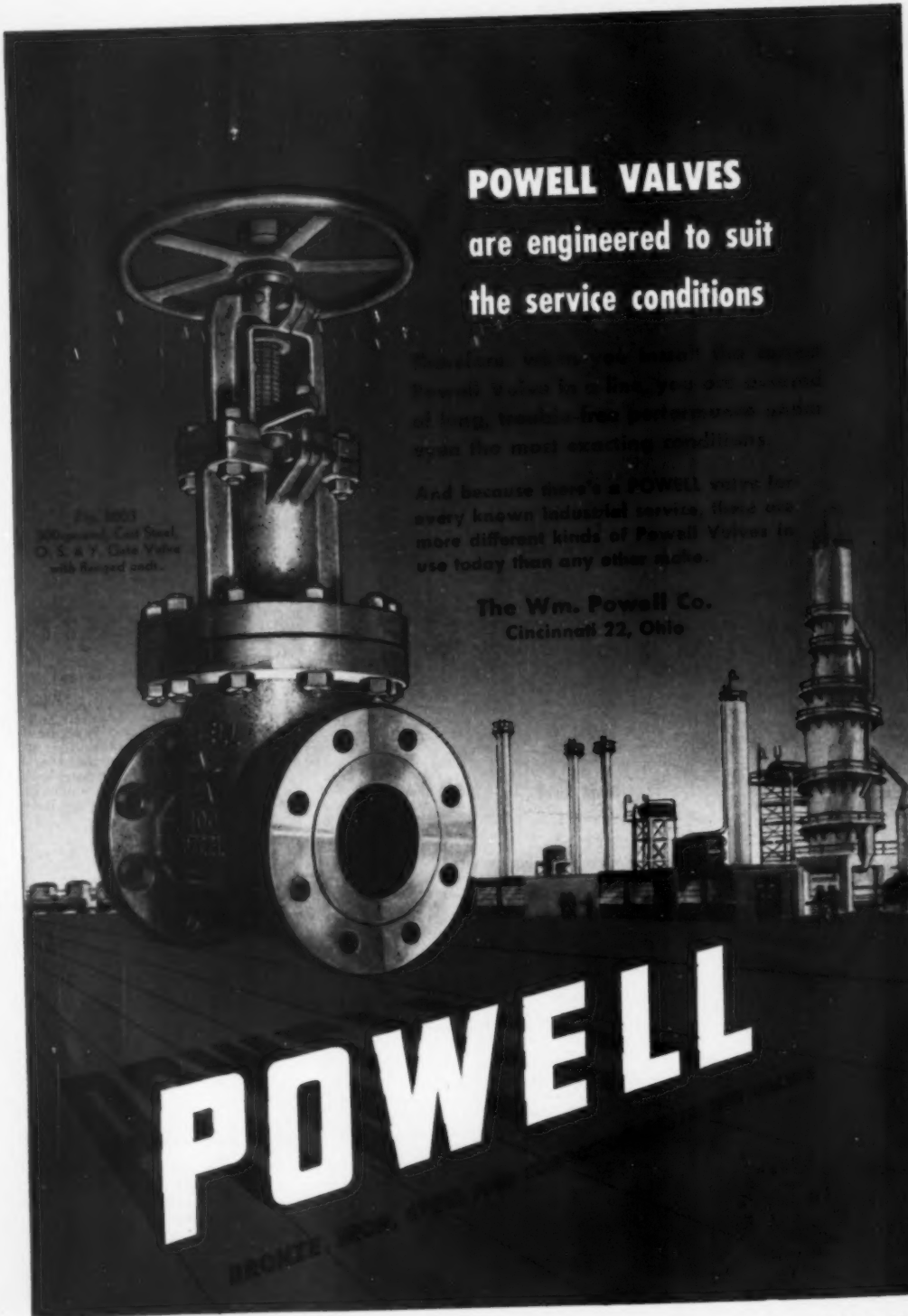
The Emil Greiner Company has issued a new leaflet describing several new laboratory instruments. Among the items listed is a new Magne-Stir, said to be the only magnetic stirrer with Teflon covered stirring magnets. It is recommended for stirring in closed systems, in a vacuum, in open systems or under pressure.

Circle No. 20 on Postcard

Automatic Pneumatic Controls

Mason-Neilan Regulator Company has just released a new series of pneumatic control instruments which are described in instruction booklets. A bulletin is in preparation and will be available shortly. The material features pressure controllers, manual control panels, and various automatic controls.

Circle No. 21 on Postcard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POWELL

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Cold Rubber Cement

A patented compound of rubber and selected asphaltic hydrocarbons, Nerva-Plast, a new product of Rubber & Plastics Compound Company, Inc., forms a tough, resilient, unbreakable elastic film on drying. The film retains its flexibility and excellent adhesive and cohesive properties under a wide range of temperature and climatic changes. Properly applied, the film affords excellent weather protection.

Circle No. 22 on Postcard

Trenching Tractors

Two models of Trenchliners, both of full crawler mounted, wheel-type machines, are offered by Parsons Company, subsidiary of Koehring Company. With a choice of two standard make 55 hp. Diesel engines, the pipeline model 215 is equipped with six digging wheel speeds up to 11.2 rpm.; 30 digging feeds from 6.2 inches to 18.5 feet per minute; nine trenching widths from 13 to 31 inches wide, and up to six feet deep. Other features include friction clutch control of digging wheel; self-sharpening "Tap-In" digging teeth; shiftable and reversible belt conveyor for discharging spoil on either side of the machine. Model 202 is specialized for drainage, irrigation, municipal and utility-type trenching projects.

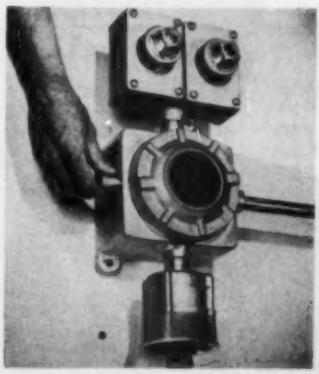
Circle No. 23 on Postcard

Reproducible Temperature Control

Accurate and reproducible temperature control have been incorporated into Minneapolis-Honeywell Regulator Company's new Pyr-O-Vane Controller designed to meet requirements for temperature control in heat-treating shops. It is described in a company Data Sheet.

Circle No. 24 on Postcard

Combustible Gas Alarm



Because of its completely explosion proof construction, the new Johnson-Williams Ltd. Model EE combustible gas alarm can be installed directly in the suspected atmosphere. Located in a bell shaped cover housing, the sensing unit is weather proof, as are all part of the unit. By convection and diffusion, the surrounding atmosphere is subjected to a continuous watch against the build up of any kind of explosive vapors. Presence of explosive vapor is signalled by a red indicator light as well as remote alarm units which can be connected to the terminals provided.

Circle No. 25 on Postcard

Fluid Processing Equipment

"Fluid Processing," a bulletin describing the application of a wide range of equipment to precision processing of fluids, is published by Selas Corporation of America. The bulletin concerns heating liquids in batches and continuously; liquid phase separation; clarification, polishing and cold sterilization. Eight types of equipment are illustrated.

Circle No. 26 on Postcard

Oxygen Indicator

Measurement of the oxygen content of industrial atmosphere is the duty performed by Mine Safety Appliances Company's new Type C-2 Oxygen Indicator. More easily operated and maintained than the previous model, C-2 has just three points which need attention: the carbon electrode which must be replaced periodically; the detector cell which requires an ounce or two oxylite periodically; and a No. 2 flashlight cell. Greater detail is published in an MS bulletin.

Circle No. 27 on Postcard

Synchronous Motors

Worthwhile reference material for engineers, the "Application of Direct-Connected Synchronous Motors to Reciprocating Compressors" is a reprint of a paper presented at the New York section of AIEE and is printed by Electric Machinery Manufacturing Company. This discussion deals largely with consideration of proper rotor flywheel effect as a preventive measure for voltage fluctuations when driving reciprocating compressors with direct-connected synchronous motors.

Circle No. 28 on Postcard

Multi-Speed Stirrer

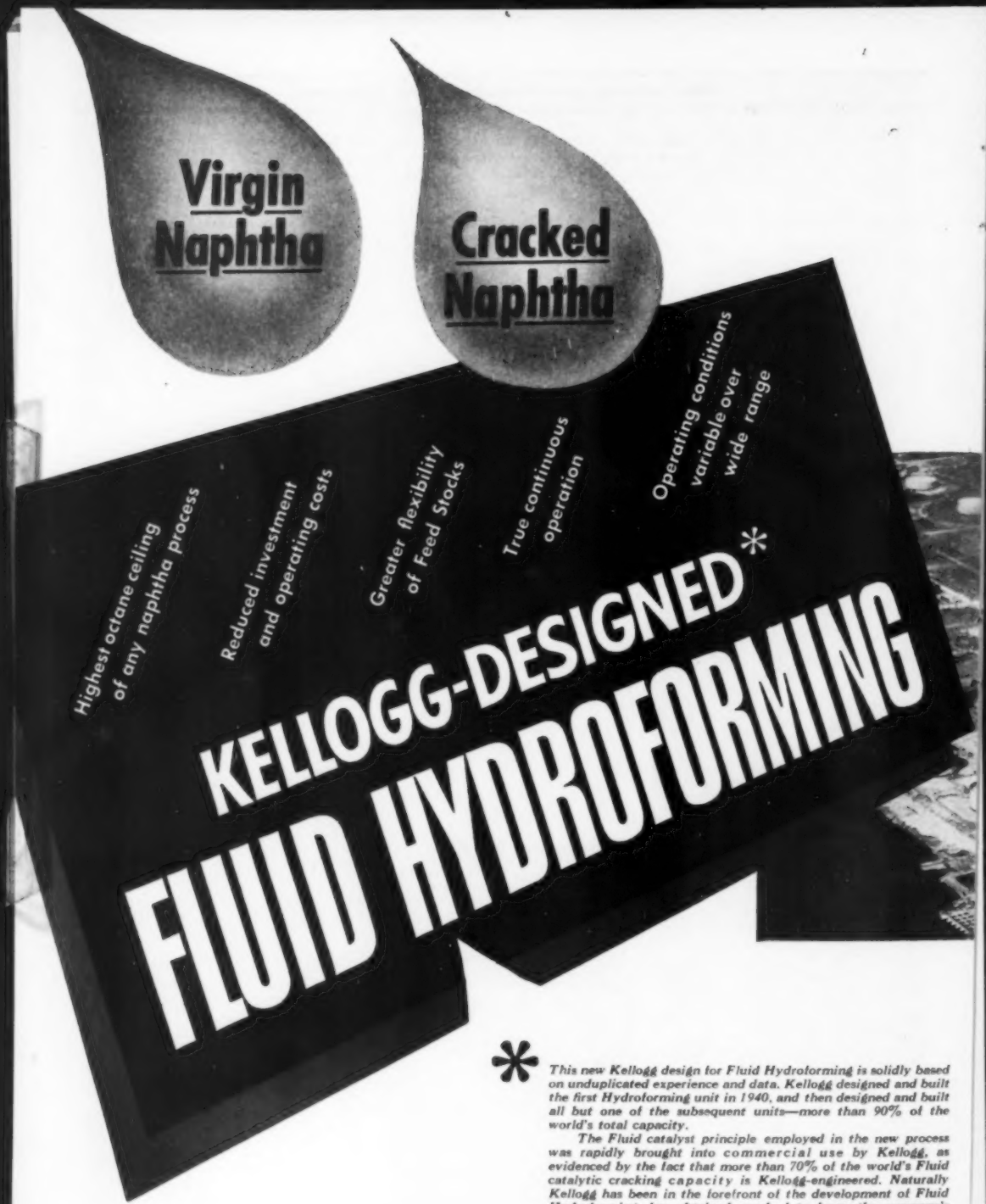
A multi-speed stirrer with speeds of 300, 600 and 900 rpm. which are preselected by a convenient knob, is manufactured by Laboratory Industries, Inc. The motor is series wound, pulls 65 watts and is 1/16 hp. A specially designed mounting bracket permits the "Mighty Midget" to be mounted in any position. The unit comes complete with three jaw chuck, two position mounting bracket, eight feet of rubber covered cord and plug, and an eight-inch aluminum support rod. A bulletin entitled "Laboratory Clamps" gives further information.

Circle No. 29 on Postcard

Aluminum Roof Coating

A new asbestos-aluminum coating for roofs which is reputed to lower underroof temperatures from 10° to 20° F. is announced by Paramount Industrial Products Company. Known as Paramount Aluma-Seal, the new roof coating reflects sun rays instead of absorbing them as do black roof coatings. The manufacturer states that this same feature of reflecting sun rays also retards the drying of waterproofing oils.

Circle No. 30 on Postcard



* *This new Kellogg design for Fluid Hydroforming is solidly based on unduplicated experience and data. Kellogg designed and built the first Hydroforming unit in 1940, and then designed and built all but one of the subsequent units—more than 90% of the world's total capacity.*

The Fluid catalyst principle employed in the new process was rapidly brought into commercial use by Kellogg, as evidenced by the fact that more than 70% of the world's Fluid catalytic cracking capacity is Kellogg-engineered. Naturally Kellogg has been in the forefront of the development of Fluid Hydroforming, has obtained much data from the company's pilot plants over a period of years and has access to all important data pertaining to the subject.

True Continuous Operation . . .

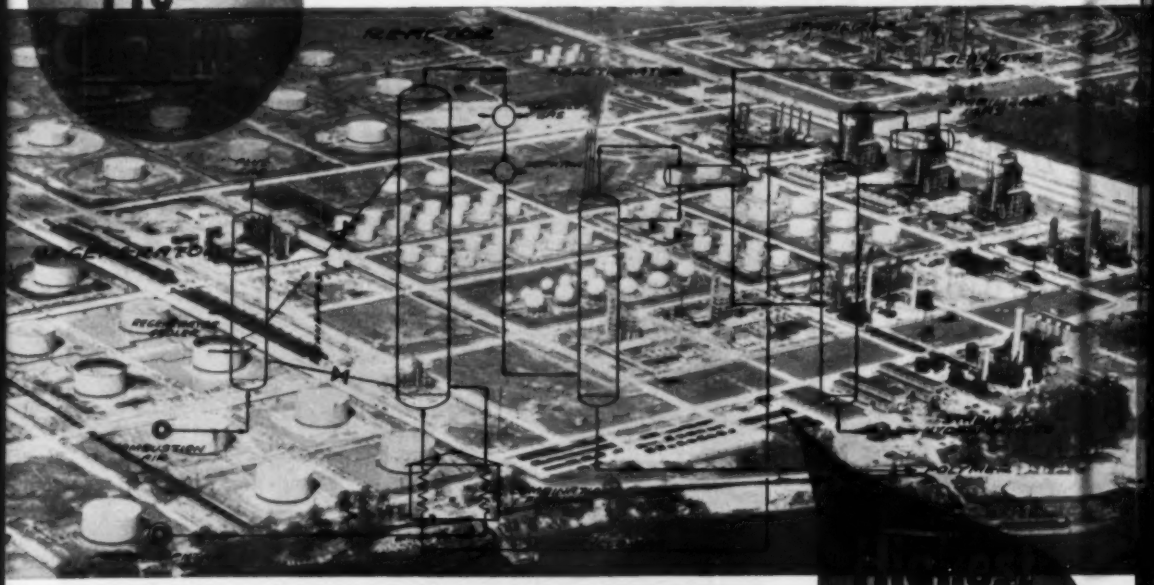
Reduced Pre-

A truly continuous process, *Fluid* **Hydroforming stands today as possibly the most important single refining development since Fluid catalytic cracking.**

Fluid **Hydroforming offers the refiner a naphtha upgrading process at considerably reduced investment cost in comparison with conventional fixed-bed reforming processes. Its operating cost is lower. But probably most important is the fact that Kellogg Fluid Hydroforming has a higher octane "ceiling" than any other process of its kind, principally because of its continous regeneration feature.**

Fluid **Hydroforming is adaptable to a wider range of feeds than other naphtha processes. Feed stocks ranging from hexane (for benzene production) to kerosene can be employed if desired.**

The process can be employed effectively to upgrade virgin heavy naphthas, and is especially effective on high-sulfur cracked naphthas or a mixed virgin and cracked feed.



Octane Ceiling

New Kellogg-Designed Fluid Hydroforming Units in Work

- ★ **2,000 BPD UNIT** for Gulf Coast refiner to upgrade straight run naphthas to produce aviation stock
- ★ **10,000 BPD UNIT** for mid-western refiner to upgrade mixture of virgin naphthas with alternate operation on pooled refinery naphthas
- ★ **20,000 BPD UNIT** for second Gulf Coast refiner to upgrade mixed virgin naphthas

For additional information, write for "FLUID HYDROFORMING", which gives detailed data on the performance, yields and octane ceilings of the process.

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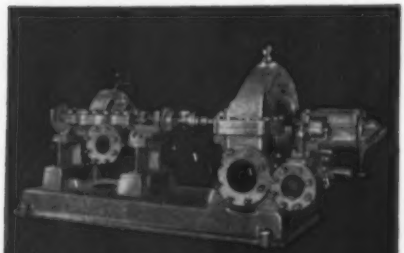

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PRESSURES UP TO 875 LBS.-750° F.

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No needless cover-ups.
Nothing fancy or frilly about these power-making huskies. Dean Hill Steam Turbines are designed and built for nothing but long service and easy, economical operation. Their heavy, rugged construction is simple and uncluttered for quick, easy maintenance. All pressure parts are outside and visible to operator.

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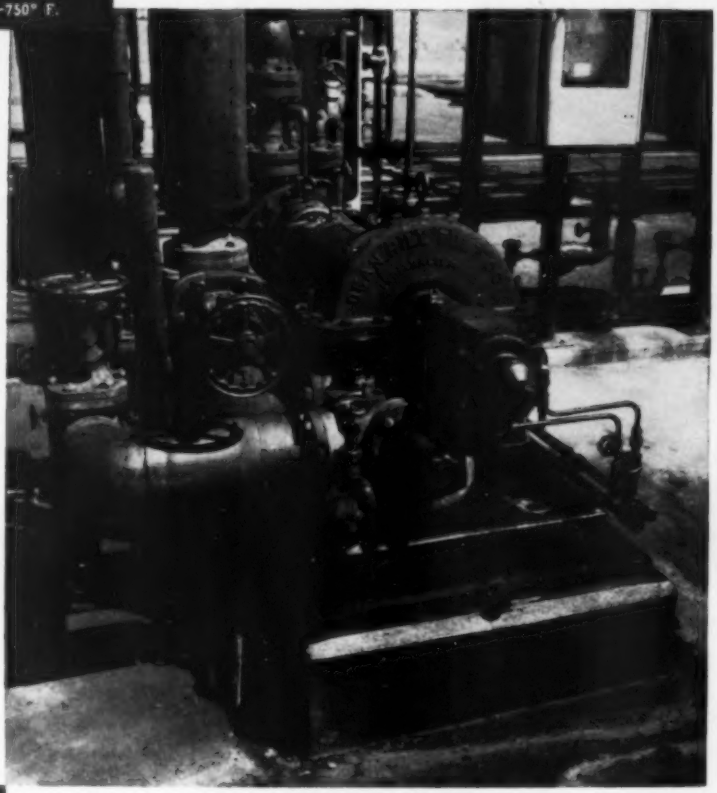
.....are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Write us for further information and complete specifications.



One of eighty-four Dean Hill Steam Turbines recently installed in a large, eastern Refinery

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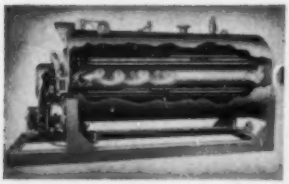
Steam Generator



Simplicity of design and construction is stressed in the new "Continental" packaged steam generator manufactured by the Boiler Engineering and Supply Company. Fully automatic and self-contained, it is said to be easy to install, efficient, and economical to maintain. One important feature is that front and back can be opened in 15-20 minutes, to provide easy access for interior cleaning and servicing. It is an improved two-pass version of the Scotch Marine type boiler. To assure maximum heat transfer and low flue gas temperature, all fuel is burned in the water-surrounded boiler furnace, and the gases pass spirally through large three-inch tubes.

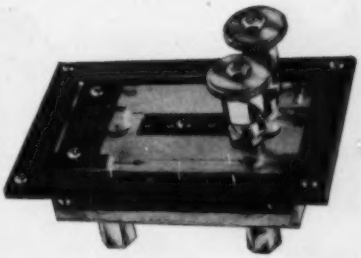
Circle No. 31 on Postcard

Plastic Chemical Vessels

Ducting systems for chemical plants made of tough, corrosion-resistant "Uscolite" plastic are now being manufactured by the United States Rubber Company. Uscolite, a blend of styrene plastic and acrylonitrile rubber combines three desirable properties, dimensional stability, toughness and chemical resistance. Reinforcing ribs, joints and corners are extruded from the plastic. Rivets are injection molded from the plastic while bolts are machined from extruded tube stock. Photo shows a processing tank hood to handle sulfuric acid mist.

Circle No. 32 on Postcard

Multiple Purge Meter



Latest development of the Brooks Rotameter Company is a multiple purge meter in a single integral unit, available in two, four or six tube units. This plastic rotameter replaces a similar number of single tube meters or bubblers for metering and regulating small flows of liquids or gases. All of the metering tubes and piping connections are precision-bored in a block of acrylic plastic, eliminating packing glands and breakable glass tubes. The meter is available with either a common manifold inlet for all the metering tubes, or individual inlets as desired. The rate of flow adjustment is made with separate Flo-Mite needle control valves for each tube. A standard bezel is obtainable for flush panel mounting of any of these meters. A bulletin with further information is available.

Circle No. 33 on Postcard

Automatic Sampling Viscometer

Norcross Corporation has developed a viscometer that automatically withdraws a small sample of liquid from a closed system, brings that sample to any desired temperature, measures and records its viscosity at that temperature, and discharges the tested sample. The instruments are equipped with alarms to signal high and low viscosities in continuous processes, and they can be furnished with automatic viscosity controlling equipment suitable for the particular application.

Circle No. 34 on Postcard

Cleaning Valves and Fittings

Reconditioning of valves and fittings can be satisfactorily accomplished with a heavy duty alkaline cleaner, Magnus 61RS, made by Magnus Chemical Company. This cleaner has a strong alkaline cleaning action, is without fumes, and is free from the hazards of caustics. Valves and fittings are loaded into an 800-gallon heated tank containing an eight ounce per gallon solution of 61RS in water. In a rolling boil some fittings are clean in 30 minutes, but one hour is enough for most valves and fittings.

Circle No. 35 on Postcard

Coated Work Glove

An all-purpose, long wearing work glove with special coating that sheds moisture and resists chemicals better than rubber is described in a new bulletin of the Mine Safety Appliances Company. The vinyl-plastic coating stays flexible in extreme cold, does not become "tacky" at any high temperature to which workers' hands are normally exposed, and is especially effective in combating strong acid concentrations, according to MSA.

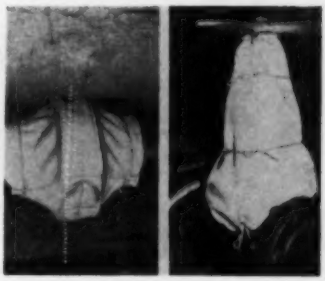
Circle No. 36 on Postcard

Conical Dry Blender

Work was recently completed on a conical dry blender that The Patterson Foundry & Machine Company believes to be the largest ever built. Thirteen feet in diameter, the unit has a total capacity of 1000 cubic feet and a working capacity in excess of 700 cubic feet. It was especially developed for blending a mixture of technical gelatin and antifoam paste. Standard Patterson design is drafted essentially for blending dry, free-flowing materials.

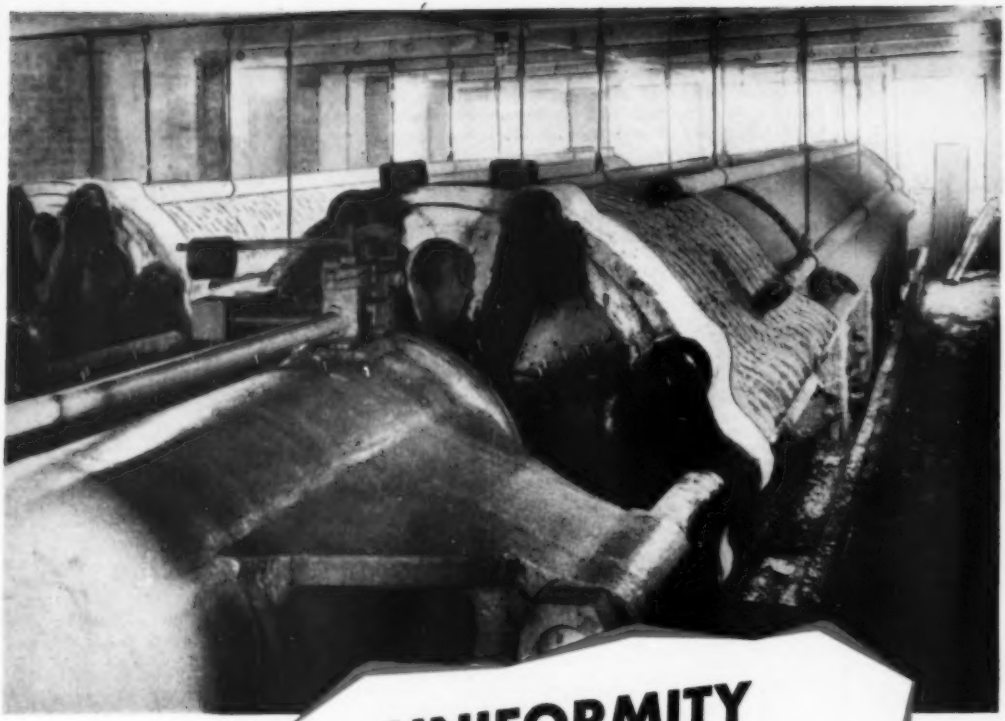
Circle No. 37 on Postcard

Valve Covers



Valve covers styled to fit one-to-six-inch pipe are being manufactured by Mine Safety Appliances Company under the trade name ChemKovers. The covers are designed to provide protection against leakage and permit complete operating freedom of the valve. Made of Dynel, the covers have sufficient strength to contain sprays resulting from gasket or packing failures of pressurized lines. Dynel fabric is highly acid and caustic resistant.

Circle No. 38 on Postcard



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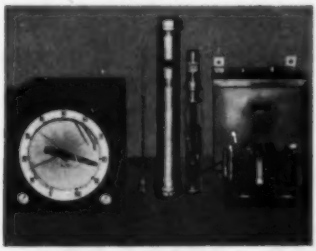
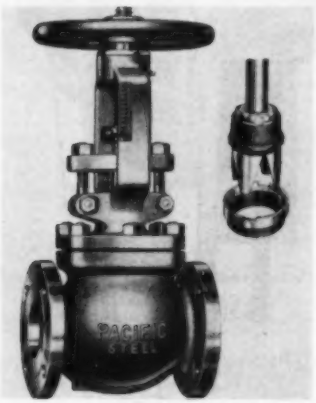
Catalyst Level Indicator



An atomic energy-operated device which measures catalyst level in a Houdriflow catalytic cracking unit has been developed by Instruments Incorporated and patented under the tradename Gagetron. The device is applicable for the measurement of all liquid levels and fluid densities through container walls, thus eliminating seals, stuffing boxes, etc. A safety code for use of radium and a bulletin on Gagetron are available.

Circle No. 39 on Postcard

Bonnet Globe Valve



Of conventional type O.S.&Y., the new "V" Port Globe Valve will prove of value in situations requiring selection for throttling service, according to Pacific Valves, Inc., manufacturer of cast steel valves. It is a bolted bonnet globe valve with a special disc designed to regulate the flow through four "V" shaped ports. (See photo.) Made of cast carbon steel they are furnished with 12 percent chromium stainless steel trim. An indicator adjusts the flow, and gives the position of the disc at a glance.

Circle No. 40 on Postcard

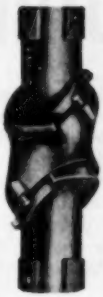
New Safety Hat

Plastiglas Hedgard, a new hat combining style and comfort with strength, high dielectric properties, unusual shock absorbing features, and design that protects the neck from dripping fluids and sun, is manufactured by the Davis Emergency Equipment Company Inc. A universal cradle is incorporated to make the hat fit every size and shape head.

Circle No. 41 on Postcard

Flexible Fixture Fittings

Made by Russell & Stoll Company, Inc., the new type CS explosion-proof, swivel-type flexible lighting fixture fittings conform to the 1951 Code and are listed with Underwriters' Laboratories. In addition they are approved for Class I, Groups C & D. The fitting is made of cast metals which can be selected for compatibility to the conduit system. The swivel joint is not subject to mechanical injury and has total swing angle of 30 degrees universal movement. Threaded joints are free-floating and high temperature lubricated to avoid freezing.



Circle No. 42 on Postcard

Safety Gloves

Long wearing horsehide GS Safti-Mitt Handpads, Style 1201, are manufactured by General Scientific Equipment Company Designed by safety glove specialists, the gloves are said to offer maximum protection and comfort against accidents, infections, etc. These gloves are especially good for use in handling brick, tile, metal sheets, and other heavy tasks where hand injuries are a risk.

Circle No. 44 on Postcard

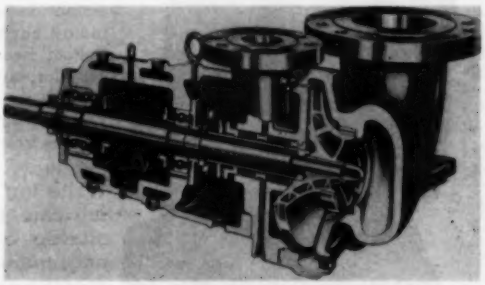
Oxygen Analyzer

The Beckman Oxygen Analyzer equipped with a Brown ElectroniK Recorder is described in a Minneapolis-Honeywell Regulator Company Instrumentation Data Sheet.

Circle No. 45 on Postcard

New Process Pump

To pump petroleum hydrocarbons, water and chemical solutions at elevated temperatures and pressures, Peerless Pump Division, Food Machinery and Chemical Corporation, recently introduced a new process pump designated as the Peerless Type PR. General characteristics show capacities up to 1000 gpm and operating heads up to 625 feet. Temperatures of liquids pumped can be up to 850° F. The horizontal electric motor drive is standard, but others, such as steam turbine or stationary engines can be furnished. Important construction features include center-line-mount design to maintain pump alignment at any temperature; positive support beneath the pump; a vertically split case, with single joint, and a fine metal clad gasket insuring tightness. Bulletin is available.



Circle No. 43 on Postcard

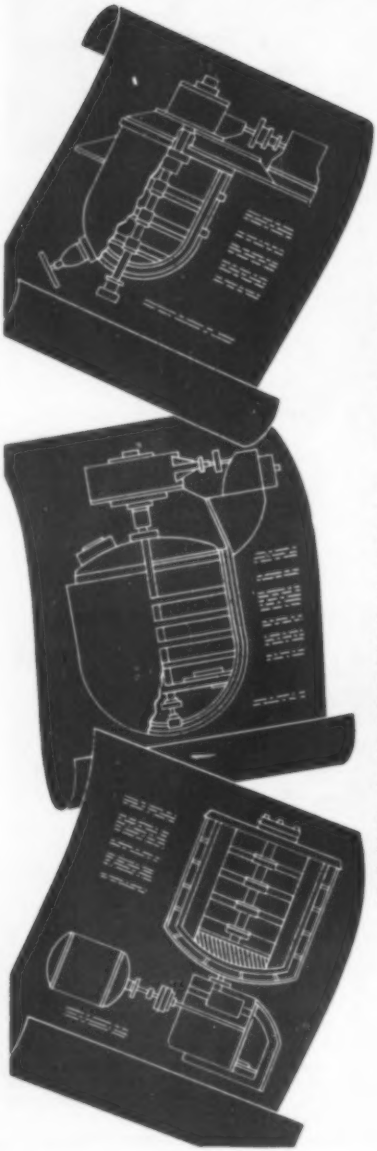
Tube Fittings

Combining data on tube fittings and tube-to-pipe adapters, fabricating equipment, and pertinent data on engineering selection and installation, The Parker Appliance Company's new volume contains illustrative and graphic material, including the ("triple-lock") standard three-piece flared-fitting.

Circle No. 46 on Postcard

DEPENDABLE

Grease Kettles by STRUTHERS WELLS



Struthers Wells will engineer mixing kettles for greases or other heavy viscous materials—to your most exact specifications and requirements. Kettles can be furnished with agitating drive at top or bottom—open, closed or pressure top—jacketed or unjacketed—in any metal or alloy desired. Advanced design provides proper seals where pressure top is used.

Sweep and paddle arms are pitched to create flow of material throughout kettle, preventing stratifying of mix. Scraper blades insure positive scraping action on about 98% of inside surface of mixer. Bottom bearing is accessible for easy maintenance or replacement. Flush type valve at bottom furnished in sizes from 1" to 8"

Write for proposal on intricate or standard mixing equipment—engineered for your specific needs.

Struthers Wells

STRUTHERS WELLS CORPORATION

Process Equipment Department • **WARREN, PA.**

Plants at Titusville, Pa. • Warren, Pa. • Offices in Principal Cities

Catalogs AND EQUIPMENT Literature OFFERED IN THIS ISSUE'S ADVERTISEMENTS

CEMENT, CONCRETE AND CASTABLE REFRACTORY GUNS—Catalog. Air Placement Equipment Co. See page 222.
Circle A1 on postcard.

HARDFACING RODS—Data. Air Reduction Magnolia Co. See page 76.
Circle A2 on postcard.

CENTRIFUGAL BLOWER — Bulletin 19B6104A. Allis-Chalmers Mfg. Co. See page 5.
Circle A5 on postcard.

EXPLOSION-PROOF MOTOR—Bulletin 51B7286. Allis-Chalmers Mfg. Co. See page 7.
Circle A6 on postcard.

ALUMINUM APPLICATIONS — Information. Aluminum Company of America. See page 217.
Circle A7 on postcard.

AIRCOOLERS — Bulletin. American Locomotive Co. See page 9.
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CONTROL VALVES—Catalog 1500B. The Annin Co. See page 49.
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ADSORBENTS—Information. Attapulgus Clay Co. See page 227.
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CENTRIFUGAL PUMPS—Bulletin 105-M. Aurora Pump Co. See page 220.
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INSULATING MATERIAL — Data. Baldwin-Hill Co. See page 219.
Circle B4 on postcard.

ANTI-FOAM AGENTS—Technical Paper 115. W. H. & L. D. Betz. See page 91.
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CORROSION PREVENTION—Bulletin. The Bird-Archer Co. See ad opposite page 65.
Circle B10 on postcard.

STEEL GRATING AND STAIR TREADS—Bulletin 2365. Blaw-Knox Co. See page 224.
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MEASURING INSTRUMENT — Catalog P1245. The Bristol Co. See pages 188 and 189.
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CAST STEEL VALVES—Catalog 20. The Chapman Valve Mfg. Co. See page 77.
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CONDENSER AND HEAT EXCHANGER TUBES—Booklet. Chase Brass & Copper Co. See page 92.
Circle C10 on postcard.

SPENT ALKYLATION ACID REGENERATION PROCESS—Data. Chemical Construction Corp. See page 38.
Circle D1 on postcard.

FLOATING ROOFS—Information. Chicago Bridge & Iron Co. See page 57.
Circle D2 on postcard.

SWIVEL JOINTS — Catalog. Chiksan Co. See page 23.
Circle D3 on postcard.

STEAM AND BUCKET TRAPS—Data. The Clark Mfg. Co. See page 210.
Circle D5 on postcard.

BALANCED SEALS—Bulletin. Crane Packing Co. See page 190.
Circle D7 on postcard.

TANK SUCTION AND DISCHARGE HEATERS—Literature. Davis Engineering Corp. See page 216.
Circle E1 on postcard.

STEAM TURBINES—Information. Dean Hill Pump Co. See page 166.
Circle E4 on postcard.

CENTRIFUGAL BLOWERS—Bulletin 1500. De-Laval Steam Turbine Co. See page 33.
Circle E5 on postcard.

MATERIAL HANDLING EQUIPMENT—Information. Dempster Brothers, Inc. See page 14.
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WATCHMEN'S CLOCKS—Folder. Detex Watchclock Corp. See page 222.
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ANTI-KNOCK RESEARCH RATA—Booklet. E. I. du Pont de Nemours & Co. See page 70.
Circle E8 on postcard.

PETROLEUM CHEMICALS—Literature and Movies. E. I. du Pont de Nemours & Co. See insert pages 192 and 193.
Circle E9 on postcard.

TUBE CLEANERS—Bulletin Y-29. Elliott Company. See page 8.
Circle F1 on postcard.

NATURAL ADSORBENTS—Data. Floridin Co. See page 32.
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AIR-COOLED HEAT EXCHANGERS—Bulletin FF-8501. The Fluor Corp. See page 40.
Circle F8 on postcard.

STORAGE TANK OIL HEATER—Bulletin 1642. The Griscom-Russell Co. See page 18.
Circle G3 on postcard.

OIL SEPARATORS—Data. Hardinger Co. See page 183.
Circle G6 on postcard.

AIR COMPRESSORS—Information. Ingersoll-Rand Co. See page 41.
Circle G8 on postcard.

MIXERS—Catalog. International Engineering, Inc. See page 200.
Circle G9 on postcard.

CORROSION ENGINEERING SERVICE—Data. The International Nickel Co. See page 100.
Circle G10 on postcard.

WIRE-MESH PRODUCTS — Information. The C. O. Jelliff Mfg. Corp. See page 228.
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INSULATING BRICK—Data. Johns-Manville Corp. See page 53.
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HEAT INSULATION—Data. Kaylo Division. See page 42.
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INSULATING MATERIAL—Information. Keasbey & Mattison Co. See page 24.
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TWIN SEAL VALVE—Bulletin. Kerotest Manufacturing Co. See page 50.
Circle H6 on postcard.

VAPOR TIGHT LIGHTING FIXTURES—Bulletin. Killard Electric Mfg. Co. See page 159.
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LIQUID PUMPS—Bulletin L51. Kinney Manufacturing Co. See page 32.
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FRACTIONATING TRAYS—Bulletin 629. Koch Engineering Co. See Third Cover.
Circle H9 on postcard.

COOLING FANS — Information. Koppers Company. See page 218.
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FILTERED WATER PUMPS—Data. Layne & Bowler, Inc. See page 198.
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SEPARATOR-FILTER-AIR ELIMINATOR—Bulletin FEQ51. Warner Lewis Co. See page 221.
Circle J3 on postcard.

IRON GATE VALVES—Circular 561. The Lunkenheimer Co. See page 182.
Circle J5 on postcard.

CONTROLLED VOLUME PUMPS—Data. Milton Roy Co. See page 25.
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PROCESS CONTROL EQUIPMENT—Information. Minneapolis-Honeywell Regulator Co. See pages 68 and 69.
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SLUDGE RECOVERY UNIT—Data. Monsanto Chemical Co. See page 63.
Circle K7 on postcard.

HEAT INSULATION — Data Manual. Mundet Cork Corp. See page 178.
Circle K9 on postcard.

STEAM TURBINES—Information. Murray Iron Works Co. See page 206.
Circle K10 on postcard.

TUBULAR PRODUCTS — Data. National Tube Division. See page 44.
Circle L2 on postcard.

STEAM TRAPS—Bulletin 152. W. H. Nicholson & Co. See page 192.
Circle L3 on postcard.

CHEMICAL CLEANING COMPOUND—Booklet. Oakite Products, Inc. See page 198.
Circle L5 on postcard.

PROCESS PUMPS — Bulletin B-1605. Peerless Pump Division. See page 21.
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LIQUID LEVEL GAGES—Catalog 35. Penberthy Injector Co. See page 153.
Circle L10 on postcard.

BUBBLE CAPS—Bulletin 21. The Pressed Steel Co. See page 15.
Circle M6 on postcard.

COOLING TOWERS—Bulletins. J. F. Pritchard & Co. See page 159.
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DEHYDRATION UNITS—Bulletin 16.0.080. J. F. Pritchard & Co. See page 228.
Circle M8 on postcard.

BAR STOCK VALVES—Data. Reading-Pratt & Cady Division. See page 223.
Circle M10 on postcard.

CONDENSER TUBES—Booklet. Revere Copper & Brass, Inc. See page 151.
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DIAL THERMOMETERS—Data. Rochester Manufacturing Co. See page 193.
Circle N4 on postcard.

VALVES—Catalog. W. S. Rockwell Co. See page 221.
Circle N5 on postcard.

VALVES—Information. Rockwell Manufacturing Co. See pages 28 and 29.
Circle N6 on postcard.

BALL VALVES—Bulletin V-4. Rockwood Sprinkler Co. See page 35.
Circle N7 on postcard.

HEAT EXCHANGER TUBES — Booklet. Scovill Manufacturing Co. See page 10.
Circle N9 on postcard.

PUMP VALVES—Catalog. Sims Pump Valve Co. See page 193.
Circle P1 on postcard.

CRANE CARRIERS—Data. Six Wheels, Inc. See page 213.
Circle P3 on postcard.

PROTECTION AND INSULATION COATING—Bulletin 101. Spring Packing Corp. See page 31.
Circle P6 on postcard.

CAST STEEL STRAINERS—Catalog 68-R. Strong, Carlisle & Hammond Co. See page 209.
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MIXING EQUIPMENT — Information. Struthers Wells Corp. See page 170.
Circle P9 on postcard.

REFINERY AND GASOLINE PLANT EQUIPMENT—Data. Superior Manufacturing Co. See page 228.
Circle Q1 on postcard.

WELDED FITTINGS AND FORGED STEEL FLANGES—Data. Taylor Forge & Pipe Works. See page 174.
Circle Q2 on postcard.

STEAM TURBINES—Bulletin S-146. The Terry Steam Turbine Co. See page 56.
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FORGING STEELS—Bulletin 31. The Timken Roller Bearing Co. See page 4.
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ALLOY STUDS—Catalog. Victor Products Corp. See page 224.
Circle Q8 on postcard.

FILM TYPE EXCHANGERS — Bulletin HE-7. Henry Vogt Machine Co. See page 61.
Circle Q10 on postcard.

PLANT CONSTRUCTION AND ENGINEERING—Literature. The Vulcan Copper & Supply Co. See Second Cover.
Circle R1 on postcard.

HARD-FACING ALLOYS—Data. Wall-Colmonoy Corp. See page 184.
Circle R2 on postcard.

AUTOMATIC CHLORINATOR—Information. Wallace & Tiernan Products, Inc. See page 194.
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BRONZE VALVES—Circular. Walworth Co. See page 55.
Circle R4 on postcard.

ALL-METAL THERMOMETERS—Catalog T-13. Weston Electrical Instrument Corp. See page 208.
Circle R7 on postcard.

ACID PUMPS—Bulletin E-7000. A. R. Wilfley & Sons, Inc. See page 27.
Circle R9 on postcard.

STEAM TRAPS—Booklet. Yarnall-Waring Co. See page 46.
Circle S3 on postcard.

How CROSBY'S BALANCED AREA DESIGN eliminates back pressure effects

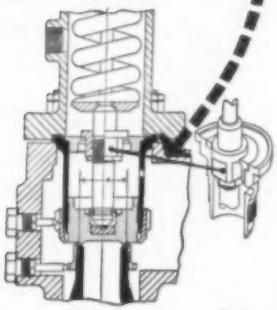


Fig. 1 Fig. 2

When a standard relief valve on gas or vapor service is installed, where back pressure exists, one of two undesirable effects will occur:

Constant Back Pressure — The back pressure acts on part of the upper and the overhanging part of the lower surface of the disc, cancelling out the back pressure force. There remains, however, a force acting on the top partition of disc (area A) which increases the spring load and causes the valve to pop "heavy."

Variable Back Pressure can not be compensated for by spring adjustments. Therefore, when one or more valves discharge into a common flare header, variable back pressure is placed on the remaining closed valves. This can create a hazardous condition on the remaining closed valves, by adding to the spring force. The valve then is prevented from opening until it has risen far above the vessel design.

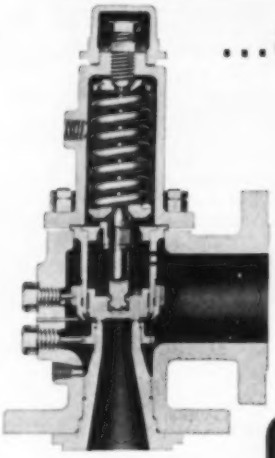
The Crosby Balanced Area Design is a simple, foolproof method of nullifying these undesirable effects (see Figure 1 above).

Operation — Crosby achieves *Stable Popping Pressure* by the addition of a piston affixed to the spindle, of area proportioned to equal the unbalanced area of the disc (area "A" in Fig. 1). Back pressure introduced through the port in the guide then acts on two equal areas in opposite directions, and cancels itself out, neither loading nor opposing the spring.

To assure full lift and stability, a vent system (see sectional view of piston, Fig. 2) is employed. When the valve is open, the flats on the piston will vent any accumulated back pressure that would tend to close the valve. The adjustment and satisfactory operating characteristics are similar to the conventional valve. The actual flow into the bonnet is relatively low and can be vented to atmosphere, or through a properly sized discharge header.

Extensive, trouble-free use in the field has proved the success of this Crosby Balanced Area Design.

Here's the [redacted] RELIEF VALVE which eliminates back pressure effects ...and reduces costs!



CROSBY RELIEF VALVE
Style JO-BP
with BALANCED AREA DESIGN
for the elimination
of Back Pressure Effects.

Proved ECONOMY!

On the many installations where Crosby JO-BP Valves have been in operation, refineries report sizable savings in piping costs. The reason—smaller discharge lines made possible by higher back pressure. Since Crosby JO-BP Relief Valves will handle back pressure surges ranging up to 90% of inlet pressure, smaller diameter discharge pipe carries the same amount over the same distance that formerly required much larger pipe.

Proved PROTECTION!

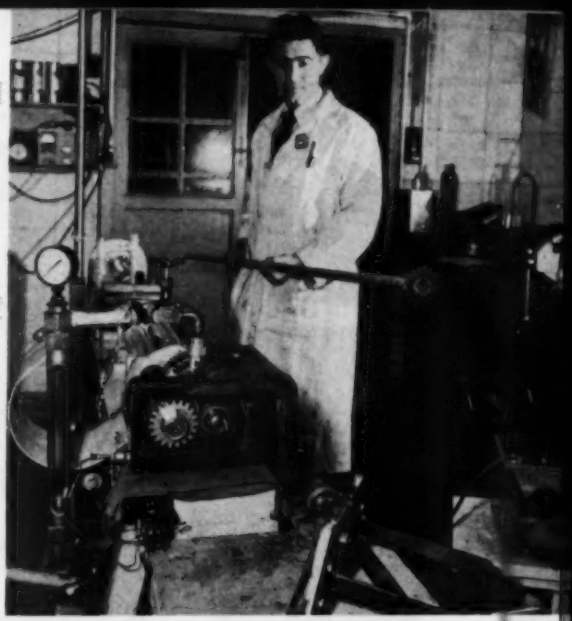
On-the-job performance of Crosby JO-BP Relief Valves proves that you can depend on the vented Balanced Design Area to operate at the set pressure. Thus you are assured of a *Stable Popping Point*. What's more, a full lift is obtained over the normal range of back pressures. The Crosby JO-BP operates with an unrestricted nozzle, follows standard nozzle flow equations for above or below critical ratio as the case may be. With its vented Balanced Area Design, the Crosby JO-BP provides a foolproof, time-tested method of eliminating back pressure effects.

CROSBY STEAM GAGE & VALVE COMPANY

43 Kendrick Street, Wrentham, Mass.

District Sales Offices:
BOSTON · NEW YORK · CHICAGO · DALLAS · LOS ANGELES

The MONTH... in the INDUSTRY



LUBE TESTING—Radioactive gear held by researcher will be placed to mesh with ordinary gear and radioactive particles worn therefrom will be measured later by a geiger counter. See item below.

WPRA Annual Scheduled At San Antonio, March 31

Featured speakers before the general sessions of the Western Petroleum Refiners Association's annual meeting being held in San Antonio, March 31-April 1-2, will be John B. Thomas, president of the Texas Electric Service Company at Ft. Worth, and John S. Coleman, president of the Burroughs Adding Machine Company, Detroit. Technical sessions are scheduled for the three morning sessions for presentation and discussion of the following:

A paper concerning the aspects of motor fuel volatility, by R. C. Alden, Elizabeth Aldrich and H. J. Elden, Phillips Petroleum Company, will be presented Monday. "The Role of Cost Accounting in Refinery Operating Control," by E. M. Skinner, Socony-Vacuum Oil Company at Augusta, Kansas, is the subject for Tuesday. The third morning features, "Houdriforming—Its Place in the Refinery," by H. D. Noll and T. A. Burtis, Houdry Process Corporation, Philadelphia, and a summary report of WPRA-Bureau of Mines Distillate Fuel Research Project by H. M. Smith, Bureau of Mines at Bartlesville, Okla. Headquarters for the meetings will be the Plaza Hotel.

Trimble Is Reappointed To Aircraft Fuels Committee

Harold M. Trimble, associate director of research in the research and development department, Phillips Petroleum Company, has been reappointed to the subcommittee on aircraft fuels of the National Advisory Committee for Aeronautics, by Jerome C. Hunsaker, chairman. Trimble has been an employe of Phillips since March 3, 1929, and his entire professional career has been confined to fuels and lubricants evaluation studies.

April Date for Gas Short Course Changed to May

Dates for the Southwestern Gas Measurement Short Course have been changed from April 8-10 to May 27-29. This change was necessitated because of the Navy's occupancy of base facilities at the University of Oklahoma at Norman, which required housing adjustment for short course participants.

Fire Closes Texas Plant

Closed for two weeks by a flash fire in the distillation tower, the damage at Skelly Oil Company's 6000 barrel daily refinery at Longview, Texas, has not been disclosed as yet, nor cause of the fire been determined.

Crude Increase Approved For Small Refiners Group

New construction among small refiners is being encouraged by the Petroleum Administration for Defense by allowing fast tax write-offs for this group. Bruce K. Brown said an analysis of certificates of necessity for new refining facilities recommended by PAD to the Defense Production Administration showed about one million barrels a day of additional capacity would be added: representing a 29 percent increase in crude refining capacity among refiners who process less than 20,000 barrels daily, and almost a 300 percent increase in catalytic cracking capacity.

Projects approved for the refining group processing over 50,000 barrels daily, represent a 15 percent increase in crude running capacity and a 41 percent rise in catalytic cracking capacity.

Intermediate refiners have been recommended for a 24 percent expansion of existing capacity, with a 53 percent expansion of catalytic cracking. PAD reports that the large refining group represents 19 companies; the intermediate group, 20, and the small refiners, 156 companies.

Phillips Investigates Solid Rocket Fuels for Army

Phillips Petroleum Company has signed an Army contract to investigate production of solid fuels for rockets and rocket motors. Initial activity will take place at Bartlesville, Okla., but a major portion of the work will be transferred to another location later on. Phillips was selected by the U. S. Air Force to conduct this work and will devote initial efforts to units providing very large but short bursts of power for assisting the take-off of aircraft. Known as Assist-Take-Off rockets, they employ solid fuels and possess no moving parts. ATO rockets are produced in small quantities at present but improvement and cost reduction may prove their practicability for commercial use.

Neutrons Indicate Lube Efficiency At Emeryville

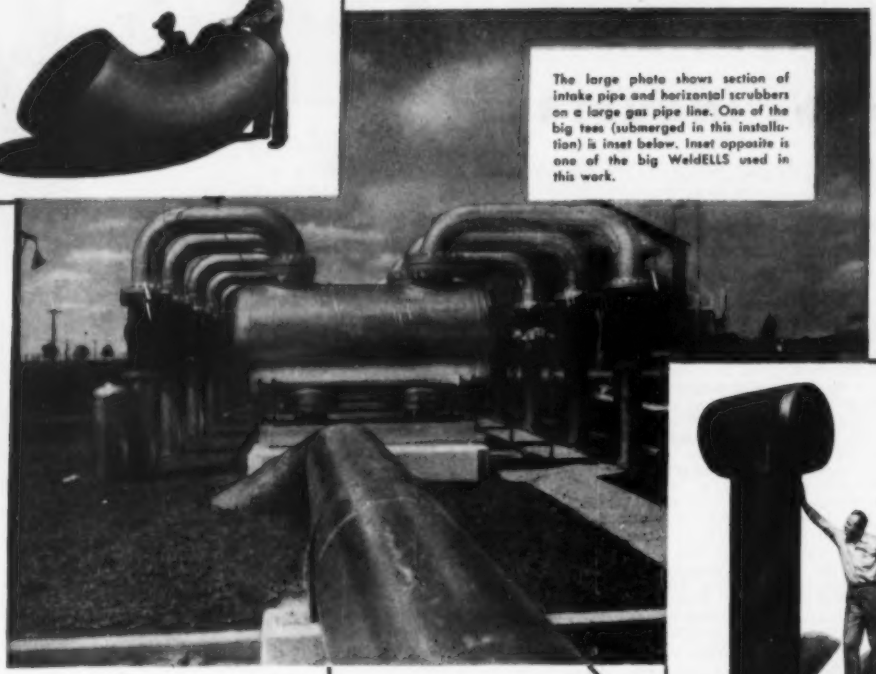
Metal gears that have been bombarded with neutrons are playing a major role in the development of the lubricating oils of the future in experiments being conducted by Shell Development Company at Emeryville, Calif. The gears, irradiated at Oak Ridge, Tenn., are rushed to the testing laboratories and Shell engineers use special tongs (see photo above) to handle the "hot" gears which are placed in special testing machines that rotate the gears in pairs so that they mesh under a variety of speeds and stresses similar to those encountered in actual industrial and automotive use.

Microscopic particles worn from the gears are rinsed away by the circulating lubricant, and a Geiger counter along the oil line immediately discloses the slightest trace of radioactive particles in the oil stream. The intensity of the radioactivity in the oil indicates the amount of wear on the gears. Photographic film placed on the normal gear after the test shows if radioactive particles have been transferred to the untreated gear, indicating less-than-ideal lubricating conditions. The tests are made by pairing one radioactive gear and one ordinary gear, which ideally, would never meet.

PAD Announces Appointment Of Five New Officers

Five appointments or promotions within the Petroleum Administration for Defense were announced last month. Carroll D. Fentriss, formerly special assistant to the deputy administrator, has been named the executive secretary of the organization. David H. West, Standard Oil Company (New Jersey), has been named director of Foreign Supply and Transportation Division. Franz Von Schilling, Jr., will be his assistant. John H. Lacy of Auburn, Ala., will succeed Samuel E. Hill as director of the Manpower Division. V. W. Ischie, Sinclair Refining Company, and sworn in as deputy director of the Foreign Refining

The large photo shows section of intake pipe and horizontal scrubbers on a large gas pipe line. One of the big tees (submerged in this installation) is inset below. Inset opposite is one of the big WeldELLS used in this work.



GUESS-WORK WON'T GO ON THE PIPE LINES

AS the demand for oil and gas mounted, the pipe lines grew. The first growth was in number and miles; then in size and pressure. The use of larger pipe lines under higher pressure has hurled a challenge at the pipe designer. To hold down costs he must press further toward the yield point of pipe line materials . . . but never too near the danger point. Sound engineering is indeed required to insure safe operation under loadings that stress materials at 65% to 85% of their yield strength. There is no "margin for ignorance" here. You must *know!*

Recent Taylor Forge contributions to the pipe lines include improved designs of WeldELLS in large sizes and tees giving greater safety at branch connections . . . produced in materials whose strength matches or exceeds that of the tough API5LX pipe now being used in transmission lines.

Ask for the facts about the WeldELL line of welding fittings and Taylor Forged Steel Flanges.

TAYLOR FORGE

TF WeldELLS®

TAYLOR FORGE & PIPE WORKS General Offices and Works: P. O. Box 485, Chicago 90, Ill. Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada.

THE OIL MAN'S CALENDAR

MAR.	
10–14	Natl. Assn. of Corrosion Engineers, Annual Conference and Exhibition, Galveston, Galvez Hotel.
16–19	AIChE, Regional, Atlanta, Biltmore Hotel.
31 to Apr. 2	WPRA, 40 Annual, San Antonio, The Plaza Hotel.
APRIL	
16–18	National Petroleum Association, Semi-Annual, Cleveland, Hotel Cleveland.
28–30	American Oil Chemists' Socy. (Spring Meeting), Houston, Shamrock Hotel.
30 to May 2	Natural Gasoline Association of America, Annual, Houston, Rice Hotel.
MAY	
11–14	AIChE, Regional, French Lick, Ind., French Lick Springs Hotel.
12–15	API, Div. of Ref. Midyear, San Francisco, St. Francis Hotel.
12–15	LPGA, Annual, Chicago, Palmer House.
26–28	AGA, Production and Chemical Conf., New York, Hotel New Yorker.
27–29	Southwestern Gas Measurement Short Course, U. of Okla., Norman.
JUNE	
23–27	ASTM Annual, Exhibit of Testing Apparatus and Laboratory Supplies, New York, Hotels Statler; New Yorker.
SEPT.	
8–12	ISA Conference and Exhibit, Cleveland.
10–12	National Petroleum Assn. (50th Annual), Atlantic City, The Traymore.
OCT.	
9–10	California Natural Gasoline Assn., Annual, Los Angeles, The Ambassador.
20–24	National Safety Council, National Safety Congress and Exposition, Chicago, Conrad Hilton Hotel.
Wk. of Oct. 27	AGA Annual, Atlantic City, Auditorium.
NOV.	
10–13	API Annual, Chicago, Conrad Hilton Hotel and Palmer House.

Division in February, became director of the division this month as G. T. Ballou, Calmara Oil Company, resigned.

Standard Indiana Promotes Three Whiting Lab Personnel

James E. Seebold has been promoted to assistant manager of research of Standard Oil Company (Indiana) with headquarters in the general office at Chicago. Robert A. Steel has been promoted to succeed him as director of the process division at the company's Whiting, Ind., research laboratories.

Dr. Seebold joined Standard in 1940 as a chemical engineer at Whiting. He received his B.E. and M.S. degrees from the University of Kentucky and Ph.D. degree from Massachusetts Institute of Technology. While at M.I.T. he was assistant professor of chemical engineering and served as director of the Parlin, N. J., station of the School of Chemical Engineering Practice.

Steel joined Standard in 1938 as a chemical engineer. After serving also as group leader, he was appointed section leader in 1946. He was graduated from Harvard and received the master's degree from M.I.T.

In addition Thomas M. Moore, a graduate of Illinois Institute of Technology, has been promoted to group leader. Moore joined Standard in 1946 as a chemical engineer and is a native of Evansville, Ind.

Eastern Refiners Charged With Heavy Water Pollution

Governors and legislators of three states were informed by the Interstate Sanitation Commission that the petroleum refining industry is the greatest single source of industrial pollution of New York, New Jersey and Connecticut coastal waters. Accounting for only 5 percent of the plants in the area, the refining industry is responsible for 65 percent of 515 million gallons per day of industrial wastes discharged by 306 plants.

Clint Barrere Heads New Lummus Office in Houston

The Lummus Company, designing engineers and constructors for the petroleum and chemical industries, moved its Houston branch organization into a new office building recently completed for the company at 2707 Weslayan Road. C. A. (Clint) Barrere, vice president, in charge of the Houston office, said that the building made possible self-contained and integrated operations.

Barrere

Work areas provide for design, engineering and construction functions, plus the various service departments to support them, thus facilitating the handling of a project from start to finish.

Formal occupancy was observed with dedication ceremonies attended by many Lummus officials, including J. F. Thornton, president of the company. An open house reception February 2 introduced the beautiful new building to hundreds who attended, and Houston officials have extended the invitation to tour the quarters to all friends of the company.

John Zink Seminar Announced

The third annual John Zink Process Heating Seminar will be held October 4 at the John Zink Company plant in Tulsa. Last year over 300 engineers and operating personnel attended the seminar which provided papers on factors pertaining to process heating and steam generation.

The Month . . .

NGAA Houston Convention Streamlined for Specialists

Due to increased registration at annual conventions of the Natural Gasoline Association of America, the usual routine of sessions is to be radically changed, when the 1952 convention meets in the Rice Hotel, Houston, April 30, May 1 and 2.

NGAA President, John F. Lynch, president of La Gloria Corporation, Corpus Christi, stated, "Operations within the industry are now so varied and personnel so divided into groups of specialists that sessions must also be divided to appeal to special groups." The NGAA convention will consist of forums on specific subjects, each held in a separate room on the same floor of the hotel and running simultaneously, each morning, followed by general sessions each afternoon with nationally known speakers.

Frank Matheny, Sid Richardson Gasoline Company, Ft. Worth, is chairman and other members of the program committee are: Z. C. Ambrose, Southwest Gas Producing Company, Monroe, La.; R. R. Dean, Del Rey Petroleum Company, Houston; John M. Kindle, Lone Star Producing Company, Dallas; H. W. Harts, Warren Petroleum Corporation, Tulsa; T. W. Legatski, Phillips Petroleum Company, Bartlesville, Okla., and R. W. Heath, Signal Oil & Gas Company, Long Beach, Calif.

Cities Service Elects McCusker Company Treasurer

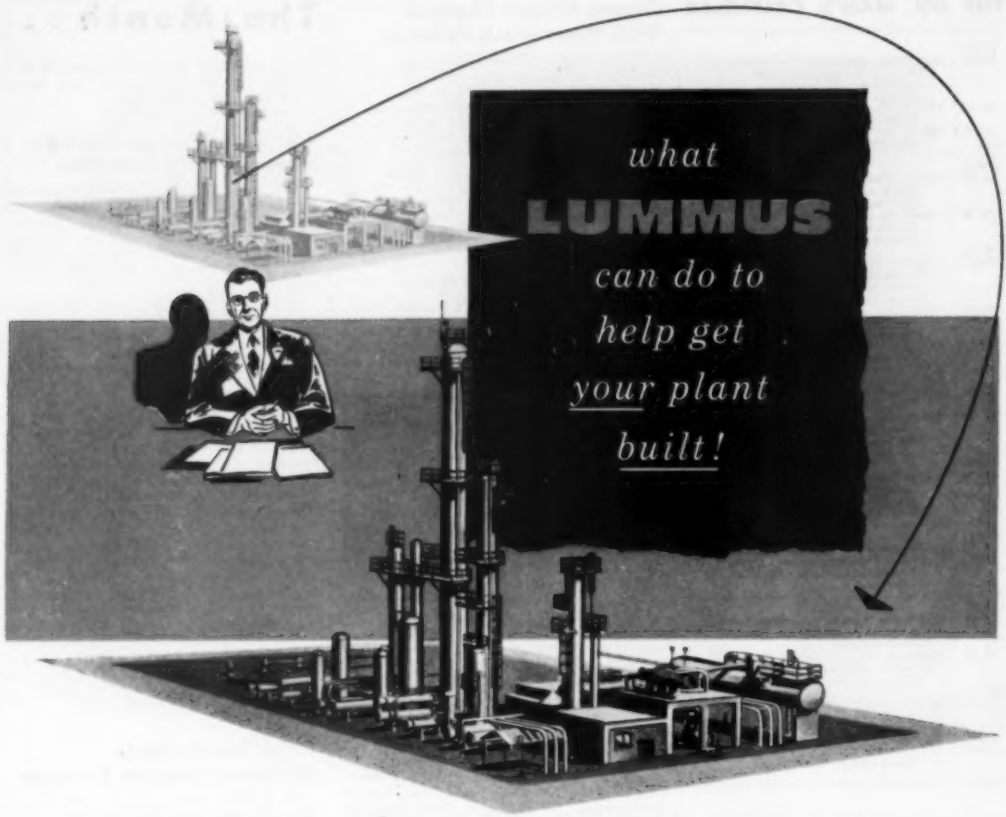
H. J. McCusker who succeeded Ernest H. Johnston as treasurer of Cities Service recently, has been associated with Cities Service since 1919 when he joined the Cashiers Department of the company. Subsequently he became manager of that department and assistant treasurer in 1942. A graduate of New York University, he is a member and former officer of the Cashiers Association of Wall Street, served with the Canadian Army, and held executive positions with the Empire Gas & Fuel Company, Cities

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1951:									
January 27	6,066	6,483	244,230	21,106	126,261	9,954	58,997	9,905	40,378
February 24	5,954	6,524	237,204	20,815	136,870	10,545	48,764	9,471	38,995
March 31	6,041	6,351	235,956	20,396	142,186	9,385	43,170	9,147	37,282
April 28	6,154	6,236	242,479	19,876	137,474	8,061	43,859	8,747	36,080
May 26	6,163	6,430	246,400	21,102	130,819	8,580	51,344	9,045	37,365
June 30	6,181	6,595	247,299	21,666	126,844	8,542	65,700	9,036	41,097
July 28	6,205	6,390	251,303	21,539	121,156	8,174	76,938	8,886	44,967
August 25	6,220	6,500	252,257	21,592	115,934	8,761	85,543	8,763	46,753
September 29	6,303	6,588	255,519	21,085	112,256	9,124	97,019	8,332	47,569
October 27	6,340	6,461	259,852	22,264	111,120	9,380	102,106	8,432	49,168
November 24	6,232	6,757	260,465	22,181	111,698	9,428	98,986	9,305	47,591
December 29	6,204	6,763	256,437	22,478	122,558	10,522	83,792	9,371	43,571
1952:									
January 26	6,194	6,344	253,186	21,649	133,861	10,391	66,450	9,222	38,725
February 23	6,366	6,599	255,194	21,528	141,765	10,552	55,055	9,024	37,111



Design, engineer and construct it? Of course. These three main classes of service—performed under *one* contract with *single* responsibility—are our bread and butter. They have produced more than 600 plants of all types in just about every country where petroleum is refined or chemicals are made.

Today's conditions, however, call for departures from "routine." Otherwise, endless complexities, shortages, etc., could require three times the normal effort to get a plant built. But Lummus has the quality and versatility of staff—the breadth and depth of operations, to meet these conditions head-on and help you maintain near-normal status.

It could work like this. In the interest of "first things first," you may need basic studies and reports covering alternative routes for reaching your goal. If so, rely on Lummus to develop analyses on which to base sound capital investment decisions.

Perhaps your problem is not so much with process units themselves, but with tying the whole system together for full operating efficiency. Lummus has long-established experience in laying out and installing complete off-site facilities—the bringing in of utilities—piping to introduce charge materials and carry off products—tankage, dockage, loading facilities, etc. This is "know-how" you can use to advantage.

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We invite you to use our various services, either singly or in combination—to get that plant *built!*

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DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

Service Oil Company of Delaware, Cities Production Corporation and Terminal Facilities, Inc.

Johnston retired last month after 45 years service.

ACS Meetings Scheduled For Buffalo, Milwaukee

Recent progress in synthetic fiber development, new findings on the effects of pesticides, and advances in brewing technology will be reported at the national meeting of the American Chemical Society, which will be held in Buffalo, N. Y., March 24 through 27 and in Milwaukee, Wis., March 31 through April 3.

Dr. Hans O. Kauffmann, director of research and development of the Buffalo Electro-Chemical Company, Inc., and general chairman of the Buffalo session, will preside over technical sessions in the Statler, Buffalo, and Lafayette Hotels. Dr. James F. McKenna, chemist with the Pittsburgh Plate Glass Company in Milwaukee, is chairman of the Milwaukee session, where sessions will be held in the Milwaukee Auditorium. Headquarters will be in the Hotel Schroeder.

Eight $1,000 awards will be conferred upon outstanding chemists and chemical engineers in the course of the two-week meeting, and the 1952 Garvan Medal for distinguished service to chemistry by a woman scientist also will be presented.

Standard Indiana Transfers Frodin to Chicago Office

L. J. Frodin of the Whiting, Ind., refinery of Standard Oil Company (Indiana) has been transferred to the company's general offices in Chicago, to become supervisor of the personnel section in the manufacturing department. He was formerly office manager at the Whiting refinery. He joined Standard in 1921.

Koa Oil Moves Headquarters

Koa Oil Company Limited, Japanese refiners, have moved their offices to No. 2, 1-Chome, Marunouchi, Chiyoda-ku, Tokyo. Koa Oil is currently expanding its refineries at Marifu and Wakayama although operating capacity of Japanese refineries is restricted by military rule.

Dr. Curme Is Director Research of Union Carbide

Dr. George O. Curme, Jr. has been elected director in charge of research of Union Carbide and Carbon Corporation to succeed the late James A. Rafferty, vice-president and director.

Dr. Curme

Dr. Curme has been a leader in the field of chemistry for many years, was a pioneer in the chemistry of aliphatic compounds, now frequently referred to as petrochemicals, and has been honored by grant of the Chandler Medal by Columbia University in 1933; the Perkin Medal of the Society of the Chemical Industry in 1935; the Elliott Cresson Medal of Franklin Institute in 1936; the National Pioneer Award of the National Association of Manufacturers in 1940; and the Willard Gibbs Medal of the American Chemical Society in 1944. He was elected a Fellow of the New York Academy of Sciences in 1950.

Named Superintendent Esso's Baltimore Refinery

Henry McBurney has been appointed general superintendent of the Baltimore refinery of Esso Standard Oil Company replacing William J. McClintock who requested to be relieved of his duties because of ill health. McBurney, previously assistant to the general superintendent, has been succeeded in that position by William J. Sheridan, formerly technical assistant to the process superintendent.

A graduate in chemical engineering from Virginia Polytechnic Institute, McBurney joined Esso in 1925.

API Committee Approves Auto Industry Cooperation

The General Committee of the Division of Marketing of the American Petroleum Institute, has approved a new system of service classifications and designations for automotive crankcase oils. The API board of directors will make final disposition of the proposal. Initial approval of the plan was given by the Lubrication Committee in Chicago last November.

The Month . . .

WPRA Industrial Relations Session Held in Beaumont

Patient planning necessary to successful industrial relations programs was pointed out to members attending the regional meeting of the Western Petroleum Refiners Association in Beaumont, Texas, last month, by Leland C. Newton, director of Safety and Personnel for the Skelly Oil Company at Tulsa, who spoke on "An Analysis of Arbitration Cases."

Other subjects presented in the industrial relations session included: the newly created salary administration program at Pan-Am Southern Corporation, New Orleans, was presented by Thomas G. Hanlon, industrial relations manager and training of supervisors at Esso Standard Oil Company, Baton Rouge, was outlined by Thomas E. W. McNeil, director of the training department.

The technical session included: an explanation of the Bureau of Mines routine crude analysis program by C. M. McKinney; results from a recent study of gasoline stability were presented by R. O. Bender, E. I. Du Pont de Nemours & Company, Wilmington; and, results of investigation regarding failure of catalytic reactor were evaluated by Vernon G. Ploeger, Humble Oil & Refining Company at Baytown. J. L. Parker, Girdler Corporation at Tulsa, presented the economics of sulfur recovery processes.

Dr. Wilson Predicts Oil Demand Curve to Level Off

Predicting that the domestic demand curve for petroleum products will "flatten off somewhat in the next few years," Dr. Robert E. Wilson, Standard Oil Company (Indiana) listed the following reasons for his statement:

Use of natural gas is increasing; fewer coal furnaces are left to convert; most large farms are already well mechanized; railroad dieselization is well developed; and fewer new cars will be available in the immediate future.

He stated that present allocations of steel would just about take care of an average annual capacity increase of four percent.

Houdry Appoints Jack Dart Research-Development Head

Four appointments in the Research and Development Department of Houdry Process Corporation concerned Jack C. Dart, who was named manager of research and development; Dr. Alex G. Oblad, associate manager; Dr. G. Alexander Mills new director of research, and Theodore A. Burtis, director of development. Their appointments augment an intensified program for the promotion of processes licensed by the Houdry organization.

Dart has been director of the Houdry development laboratory since 1947, hav-

CLOTHING MADE OF PETROLEUM products is worn by Dr. Gustav Egloff, research chemist, in the photo above as he displays apparel items, furs and fabrics—all made of petroleum products—before a recent meeting of the Oil Men's Club of Kansas City. To his left are samples of the chemicals from which the finished products were made. Dr. Egloff, who spoke on "The Modern Oil Industry," was wearing a suit, tie and shirt that were made of petroleum products. An address on a similar topic was given before the Rotary Club of Houston on March 6 by Dr. Egloff.

. . . NEW Heat Saving Efficiency

MUNDET 85% MAGNESIA INSULATION provides maximum strength and resistance to vibration. Extra durability is built into this insulation. In pipe covering and blocks, it is precision manufactured on the latest type of automatic equipment to insure uniform standards. It does not "powder", settle or disintegrate. It is unaffected by steam or water leakage. It maintains an attractive, smooth finish. Precision pipe fit is assured, with no spaces left for the escape of heat. You benefit from the most modern manufacturing facilities for the production of heat insulation when you specify Mundet 85% Magnesia Pipe Covering and Blocks.

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INSULATION FOR HIGH & LOW TEMPERATURE

The Month . . .

ing previously been associated with four major companies in the refining and engineering fields. Dr. Oblad also has been with Houdry since 1947. He had held research posts with Standard Oil Company (Indiana), Magnolia Petroleum Company and the Texas State Research Foundation, and is secretary of the Petroleum Division of the ACS.

Dr. Mills joined Houdry in 1940, having served as a member of the chemistry department at Dartmouth College. He became assistant director of research in 1947. American Association for the Advancement of Science and the American Ceramic Society. Burtis has been chief of the economics section of Houdry's research and development department since 1947, having had previous engineering experience with Magnolia Petroleum Company and Owens-Corning Fiber Glass Company.

Wilshire Oil Appoints Behrens A Vice President

Fred B. Behrens, appointed vice president of Wilshire Oil Company, Inc., Los Angeles, will retain his former responsibilities as manager of manufacturing and add engineering, pipeline and storage operations, and crude oil purchases and exchanges, to his duties.

Behrens

A graduate of the University of Wisconsin, 1928, he joined Universal Oil Products Company that year in its control laboratory. Following assignments in experimenetal laboratory work, pilot plant cracking and non-selective polymerization. He joined the refinery staff of Wilshire Oil Company as Treating Superintendent in 1936, and subsequently was promoted to assistant refinery superintendent and then manager of manufacturing.

Esso Names John Waybright Manager of Everett Plant

Esso Standard Oil Company has appointed John J. Waybright, formerly assistant to the general superintendent of the Bayway, N. J., refinery, as manager of the Everett, Mass., refinery. Waybright succeeds Charles H. Cole who has been named assistant manager of manufacturing for Creole Petroleum Corporation at Caracas, Venezuela.

Waybright joined Esso in 1934 following his graduation from the U. S. Naval Academy.

Automatic Recorder Unveiled At ISA Regional Meeting

A new device that automatically reports, records and prints as many as 400 different conditions in an electric power plant was introduced at the regional conference of the Instrument Society of America sponsored by the New York section, by Taller and Cooper, Inc. of Brooklyn. The new instrument employs electro-mechanics and electronics and is reportedly applicable to oil refineries,

TO MAKE CERTAIN you get the latest, most convenient and most accurate pH equipment, be sure to specify "BECKMAN" . . .

* Beckman pH equipment is completely electrometric, eliminating the mess and inaccuracies of colorimetric methods. Simply press a button and the exact pH of any process is instantly shown on a large easily-read dial. *It is the simplest of all pH methods!*

* With Beckman equipment no time-wasting or troublesome sampling devices are needed. Beckman pH electrodes may be installed directly in vats, tanks, channels or flow lines—and exact pH values read instantly—and *continuously*, if desired—on the process fluids themselves.

* The accuracy of Beckman pH readings is completely unaffected by human errors in color judgment, by turbidity, oxidizing or reducing agents, by suspended materials, colored process solutions or other variables that affect outmoded colorimetric methods. *Beckman pH readings are universally accurate and dependable!*

* Unique rugged-type Beckman Electrodes, especially designed for direct immersion in abrasive or suspension-laden fluids, reduce maintenance to an absolute minimum. *Beckman is the most trouble-free of all pH equipment!*

The above are only a few of many Beckman advantages. Write for the complete story.

LEADING REFINERIES are using Beckman pH Control for many profitable applications that save time, save money, minimize maintenance and increase plant efficiencies. Whether yours is a small or a large refinery, be sure to investigate the savings to be made by such typical applications as these . . .

- **NEUTRALIZING CRUDE STOCK ACIDITIES** to prevent damage and corrosion to costly plant equipment.
- **MAINTAINING CONSTANT COOLING WATER CHECK** for immediate detection of hidden leaks in lines and equipment.
- **TREATING PROCESS AND BOILER FEED WATER** to assure soft, neutral water, greater freedom from liming and boiler maintenance, and substantial savings in chemicals.
- **NEUTRALIZING ACIDS IN STILLS** to assure a uniform, acid-free product.
- **ACCURATE CONTROL OF WASTE DISPOSAL** with better neutralization of acid and caustic effluents . . . at substantially lower chemical costs.

. . . and many other savings in modern refinery and production operations.

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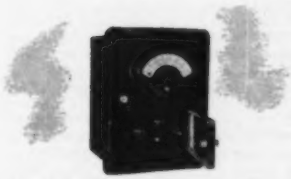

COMPLETELY AUTOMATIC! The Beckman Model R instrument operates directly from standard 110 v. A.C. lines to provide completely automatic pH indication. Also provides for completely automatic pH recording and automatic process control. Can be installed to give accurate pH readings from various stations in plant through one instrument. *This is the pH unit being installed by today's most modern plants, large and small.*

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COMPLETELY SELF-CONTAINED! The Beckman Model N is the ideal instrument where *complete* portability is desired. Operating from its own self-contained, long-life power supply, the Model N can be used *anywhere*—in plant, field or laboratory—without dependence on A. C. power circuits. Features maximum compactness, simplicity and operating convenience, coupled with extreme ruggedness. Available in two types . . . the N-1 with separate Buffer, KCl solution and beaker . . . the N-2 with integral case for Buffer, KCl solution, beaker, thermometer, etc.

BRING YOUR pH PROBLEM TO US. Our trained engineers will gladly study your problem and recommend the equipment best suited to your particular requirements. No obligation, of course.

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★★★ RIDGID Work-Saver Pipe Tools ★★★

The Month . . .

etc., where production and quality control is essential.

The automatic data recorder and annunciator, the only one of its kind in the world, is being installed in the Johnsonville, Tenn., power plant of the Tennessee Valley Authority, and will report, record and print when and where conditions occur as well as when the situation is restored to normal.

Cities Service-Delaware Names Irelan President

Major changes in top executive posts of the Cities Service system, created the

Irelan

Ambrose

following promotions:

A. W. Ambrose, president of Cities Service Oil Company of Delaware, with headquarters at Bartlesville, Okla., and operating a fully integrated oil business in the Mid-Continent area, becomes chairman of the board of that company. Succeeding Mr. Ambrose in the presidency will be S. B. Irelan, since 1944 president of the Cities Service Gas Company with headquarters in Oklahoma City. Irelan will be succeeded in the presidency of the gas company by Glenn W. Clark, since 1944 vice president and general counsel of that subsidiary.

By assuming the chairmanship and turning over to Irelan the administrative direction of the company, Ambrose completes an executive reorganization program which he initiated last year and which will enable him to devote his principal attention to the extensive exploration and production activities of the company in both the domestic and foreign fields.

Irelan has been associated with Cities Service since 1909 and has been for many years a key executive in the management of various Cities Service properties in the electric utility, natural gas and petroleum fields. As president of Cities Service Gas Company he has directed the construction and operation of several major pipelines, the most recent being the 26-inch Hugoton line extending from the Hugoton natural gas field in Kansas and Oklahoma to Kansas City, Mo.

Rotocel Extractor Designer Promoted by Blaw-Knox

George Karnofsky, inventor of the Botocel Extractor, has been appointed assistant to the director of research for Blaw-Knox Company, Chemical Plants Division.

Karnofsky joined Blaw-Knox in 1943, and while a member of the research staff of the fabricating division at Blawnox, Pa., developed the Rotocel, a proprietary device increasingly used for the solvent

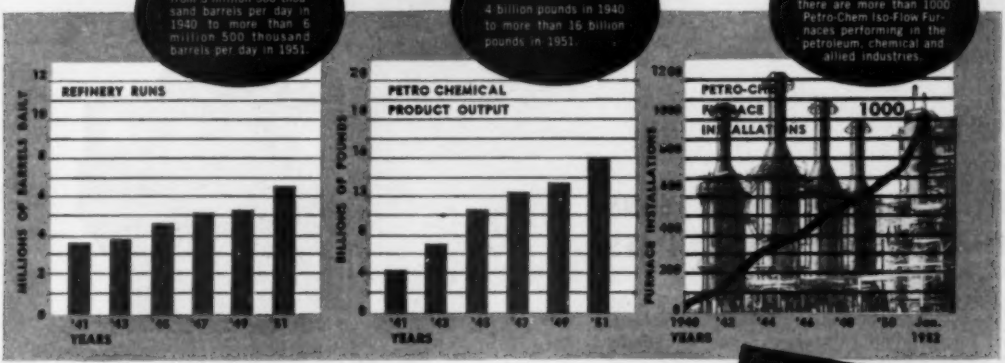
CONFIDENCE spells growth

There's many a reason for the parallel growth of the Petro Chemical Industry and the increasing use of Petro-Chem Iso-Flow Furnaces by leading Petro Chemical Companies.

Runs to stills in U. S. oil refineries increased from 3 million 500 thousand barrels per day in 1940 to more than 6 million 500 thousand barrels per day in 1951.

Petro Chemical production has increased from 4 billion pounds in 1940 to more than 16 billion pounds in 1951.

In 1940 there was 1 in 1946 there were 400 and as of Feb 1952 there are more than 1000 Petro-Chem Iso-Flow Furnaces performing in the petroleum, chemical and allied industries.



ISO-FLOW FURNACE USERS KNOW . . . that the Petro-Chem Development Company has but one basic product; processing furnaces for petroleum, chemical and allied industries. As a result of experience, they know that it does not pay to build their own furnaces; that Petro-Chem Iso-Flow Furnaces cost less, operate efficiently and usually beyond their rated capacity . . . they know that all process data made available for the design and engineering of Petro-Chem Iso-Flow Furnaces is kept strictly confidential . . . never released by Petro-Chem Development Company engineers.

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There's a PETRO-CHEM ISO-FLOW FURNACE for every process requirement of the petroleum and chemical industries

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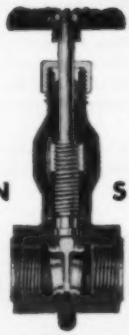

Fig. 1640
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extraction of soybeans, cottonseed, and other materials. Prior to his association with Blaw-Knox, Karnofsky was engaged for five years in developmental work for a major oil company. He is a chemical engineering graduate of Cooper Union College in New York (B.S. degree), and Purdue University (M.S. degree).

Standard Indiana Votes To Increase Directors

Directors of Standard Oil Company (Indiana) have voted to ask stockholders to approve, at the coming annual meeting, an increase in the permissible maximum number of directors from 12 to 15. The names of David Graham and John E. Swearingen would be placed on the ballot as management nominees for election to fill two of the vacancies. All present directors are being nominated for re-election.

Graham, financial vice president of Standard since January, came from a similar position with the Weyerhaeuser Timber Company at Tacoma, Wash.

Swearingen joined Standard Oil Company in 1939 as a chemical engineer in the Research Department at Whiting.

Dewey & Almy Chemical Names Haslam Director

Robert T. Haslam, newly elected member of the board of directors of the Dewey and Almy Chemical Company, is a former vice-president and director of Standard Oil Company (N. J.), and active president of the United States Pipe Line Company, a director of W. R. Grace & Company of New York; a director and member of the executive committee of Ethyl Corporation and a director of American Gas & Electric Company and Worthington Pump and Machinery Corporation.

Prior to joining Standard Oil in 1927, Haslam was professor of chemical engineering at Massachusetts Institute of Technology and is now a member of the corporation of M.I.T.

Joins Dallas Consultants As Process Consultant

J. C. Shaw, formerly with the Esso Engineering Division of the Standard Oil Development Company, has joined Purvin and Gertz, consulting engineers of Dallas. Shaw, who holds a M.S. degree in chemical engineering from Carnegie Institute of Technology, has had experience with the Technical Service Division of the Humble Oil and Refining Company also. He will serve the consulting firm as process consultant for petroleum refining and natural gasoline problems.

ASA Membership Increase Notes 84 New Members

Forty-five companies and one technical society now represent the valves and fittings industry in the American Standards Association, revealing a membership increase of 12 trade associations and 84 individual members.

During 1951 ASA approved 113 American Standards, bringing the total number of new and revised American Standards in effect to 1181. Newly approved American Standards of particular interest to the valves and fittings industry in-

95% OF OIL RECOVERED FROM REFINERY WASTE WATER BY HARDINGE SEPARATORS

(Above) Part of the Hardinge installation of 21 rectangular clarifiers (oil separators) which remove about 300 barrels of heavy emulsion per day from 35,000 g.p.m. of refinery waste water at two Ohio refineries.

(Right) Aerial view shows primary clarifier in center with 10 secondary clarifiers on each side. The waste water enters through the culvert in the center and the effluent, with 95% of oil removed, flows out the canal at left.

300 Barrels Per Day Recovered

With increased demands for better methods of handling refinery waste water, systems using Hardinge Clarifiers as the primary separator have been gaining in popularity because of the high recovery of oil from the waste water. In this Ohio installation, the effluent from the Hardinge system contained 80 to 85% less oil than the previous system. Our engineers will provide you with the facts that you require.

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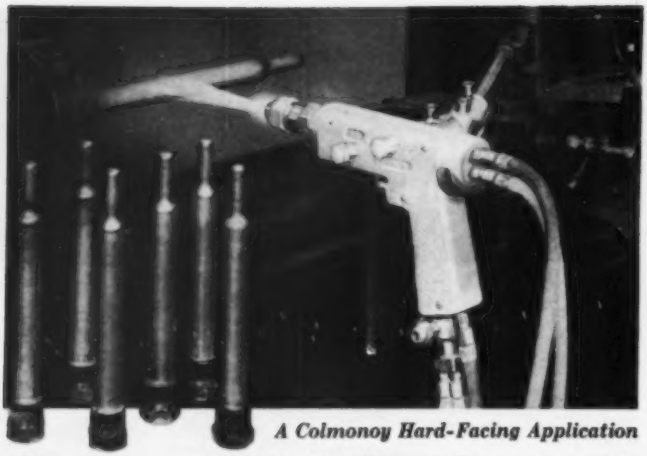

A Colmonoy Hard-Facing Application

Thermocouple Wells Hard Faced with SPRAYWELDER last 7-10 times longer

The fast destruction of thermocouple protection tubes may now be prevented by the use of a remarkable hard-facing alloy and a metal-spray welding method called the COLMONOY SPRAYWELD PROCESS.

The photograph shows a thermocouple protection tube, made of inexpensive mild steel, mounted on a lathe. A powder spray gun, the Spraywelder, is spraying COLMONOY No. 6, an extremely erosion, oxidation, and corrosion resistant nickel alloy. After spraying, the deposited alloy is fused to the base metal with an oxy-acetylene torch. The result is a smooth, welded overlay, as shown on the tubes above. When placed in service, tubes like these have given from seven to ten times the life of tubes previously used.

The COLMONOY SPRAYWELDER has many profitable uses in the process industries. While the method illustrated above lends itself especially to cylindrical parts, such as pump shafts,

sleeves, plungers, pistons, etc., any part, regardless of shape and contour, may be sprayed. Because the overlay may be held to within .010" of the desired size, less alloy is used and far less grinding is required than with other hard-facing methods. The Spraywelder may also be used as a standard metallizing gun, will spray copper, aluminum, stainless steel, etc.

COLMONOY No. 6 has many other applications. In the form of gas welding rods it is used for hard-facing valves, valve seats, pump seal and wear rings. COLMONOY No. 6 may also be cast for small precision parts.

COLMONOY is a complete line of hard-facing alloys, made to resist impact, abrasion, and corrosion, singly or in combination. To accomodate application methods, they come in various forms: powder, rods, electrodes, paste, and metallizing wire.

Write and ask for more information: about COLMONOY alloys, about equipping yourself with a Spraywelder, or for the name of your nearest Sprayweld shop.

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The Month . . .

cluded: ring-joint gaskets and grooves for steel pipe flanges, B16.20-1951; non-metallic gaskets for pipe flanges, B16.21-1951; wrought copper and bronze solder joint fittings, B16.22-1951; and malleable-iron screwed fittings, 150 pounds, B16.3-1951.

Stanolind Establishes 14 Advance Study Fellowships

Stanolind Oil and Gas Company has announced the establishment of 14 fellowships for advanced study and research in various fields of petroleum science at 12 colleges and universities for the school year of 1952-1953.

Among the fellowships, each valued at $1,250, plus tuition and laboratory fees, are: University of Kansas, mechanical engineering; University of Michigan, chemical engineering; University of Pennsylvania, accounting; Pennsylvania State College, petroleum engineering.

The fellowships are available to all qualified graduate students upon application to the respective universities. Throughout the tenure of the fellowships, company representatives from the various departments interested in the work will maintain contact with the fellows in order to discuss practical as well as theoretical aspects of the problems.

Blaw-Knox Division Adds Three Construction Men

Continuing its expansion, Chemical Plants Division of Blaw-Knox Company has appointed three district superintendents of construction. John W. Hubbard, who joined the company recently, will supervise the division's building activities for the oil and gas industries and for the process industries generally in the southwest. Hubbard, a graduate of the University of Oklahoma, will make his headquarters at Tulsa.

The other appointees are Herbert Morgan, Jr., and J. C. Tooke, both of whom will have their headquarters in Pittsburgh.

Standard Indiana Appoints Manufacturing Engineers

Standard Oil Company (Indiana) has made several personnel changes in its manufacturing engineering department. Wallace B. Mathews has been appointed co-ordinator of engineering and engineering research; Wilbur G. Guild and Ben Franklin have become assistant chief engineers, and Robert R. Penman has been appointed head engineer.

Mathews, formerly assistant chief engineer in the general office, joined Standard in 1923 and is a graduate in mechanical engineering from the University of Illinois.

NGAA Permian Basin Meet Attracts 425 to Odessa

Attended by 425 men in the natural gasoline industry, the Permian Basin regional meeting of NGAA on February 28, Odessa, Texas, featured a day-long session, which included a tour of the sulfur recovery unit at the Odessa Natural Gasoline Company plant. The morning session included papers by William Boles, Lunkenheimer Com-

pany, on "Valve Maintenance;" C. C. Homan, El Paso Natural Gas Company, "Gas Turbine Driven Centrifugal Compressors;" and Clyde L. Blohm, The Fluor Corporation, "Processing Sulfur Bearing Gases."

The afternoon session featured an address by John Ben Shepperd, Secretary of State, Austin, who pointed to the irresponsibility of the public as the major factor in the moral decay of government. Sam Carney, retired from Phillips Petroleum Company, gave an illustrated talk on "Plant Engineering of the Past," which traced the development of natural gasoline processing up to the present day. The banquet was highlighted by movies on big game hunting in Africa, presented by John I. Moore, independent oil operator from Midland, Texas.

Dr. Hinds Is New Conoco Petrochemical Assistant

Dr. George E. Hinds, 43, has been appointed assistant to the manager of Continental Oil Company's petrochemical department, with headquarters in Houston. Dr. John E. Kircher is department manager.

Hinds

A native Texan, Dr. Hinds was until recently director of technical coordination for Sharples Chemicals, Inc., at Philadelphia. While in Philadelphia, Dr. Hinds held the position of assistant to the vice president in charge of research and development, and for several years was in charge of the firm's technical publications and product advertising.

Morris E. Leeds Dies

Morris E. Leeds, founder and chairman of the board of Leeds & Northrup Company, died last month at Lake Wales, Fla. Among the many honors given him were: the Institute of Management's Henry Lawrence Gantt Medal for industrial relations achievements; the Edison Medal of the American Institute of Electrical Engineers awarded for the development and production of instruments and controls; the Edward Longstreth Medal of the Franklin Institute for invention of the instrument known later as the Leeds Recorder, which was the first balance-method industrial recording instrument. The Philadelphia Chamber of Commerce made him the first recipient of its Annual Award for leadership in industrial relations. He held honorary degrees from Haverford College and Brooklyn Polytechnic Institute.

Oil Company President Dies

William H. Oldacre, president and general manager of the D. A. Stuart Oil Company, Chicago, for the past 32 years and active in many technical societies, died early this year. A prominent leader in NIGI, he had served on the board of directors since 1936, and his specialized interests in metal cutting made him an outstanding source of information on sulfurized and sulfo-chlorinated oils and lubricating greases.

Emma Crandal, Well-Known Literature Chemist, Dies

Miss Emma E. Crandal, 78, distinguished literature chemist in the field of petroleum, and able organizer and librarian of the Universal Oil Products library at Riverside, Ill., died early this year. Presiding 20 years over the UOP library which she established when she joined the company, she was at the same time compiler and editor of the UOP "Library Bulletin of Abstracts," a weekly publication with worldwide distribution. Avidly interested in minority problems, she edited "Our Minorities" even last summer while recovering from a heart attack. W. H. Barbee, 246 Washington Avenue, La Grange, Ill., is heading a Emma E. Crandal Memorial fund.

The Month . . .

Weil, Retired General Petroleum President, Dies

Adolph Leonard Weil, retired and a 1899 law graduate, died last month at his home in Los Angeles.

Weil had been connected with the oil industry since 1899 and his practice included problems relating to land, legislation and taxation for several oil industry clients.

In 1910 he handled the incorporation of the Esperanza Consolidated Oil Company which later became General Petroleum. He served as general counsel for General Petroleum from 1910-1940, and as president from 1934-1940.

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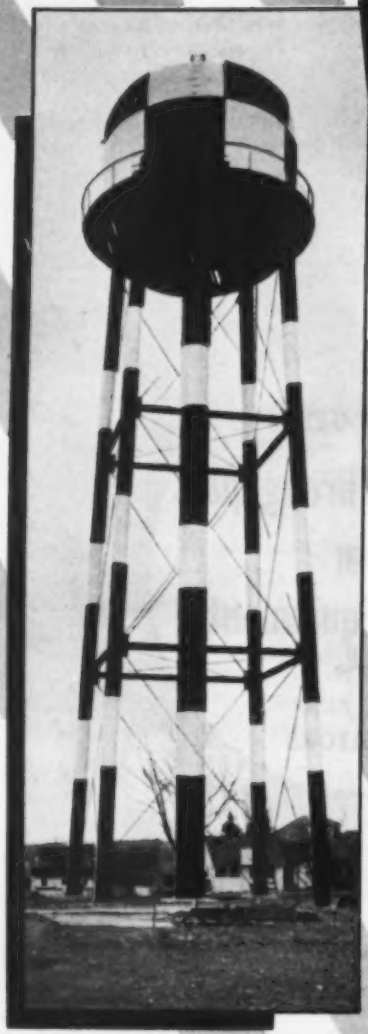

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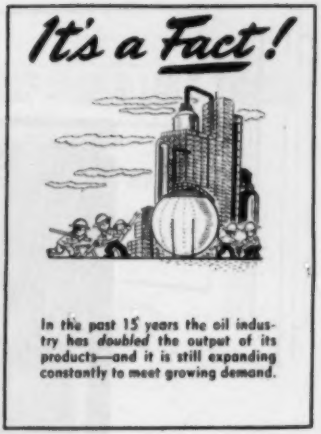

In the past 15 years the oil industry has *doubled* the output of its products—and it is still expanding constantly to meet growing demand.

Fundamental Physical and Chemical Data

An Empirical Equation For Thermodynamic Properties of Light Hydrocarbons and Their Mixtures. Reduction of Equation to Charts for Prediction of Liquid-Vapor Equilibria. MANSON BENEDICT, GEORGE B. WEBB, LOUIS C. RUBIN, LEO FRIEND. *Chem. Eng. Progress*, **47** (1951), pp. 609-20.

This is the concluding part of a paper started in the August, 1951, issue of Chemical Engineering Progress and continuing in the September and November issues. The final charts as prepared are presented. In all, 324 charts were prepared for 12 hydrocarbons at 26 pressures between 14.7 and 3600 psia. The temperature range covered was —100 to +400° F. and the molal average boiling point range from —255° to +180° F. at pressures up to and including 1000 psi. charts representing K-values were prepared. At pressures between 1000 and 3600 psi. fugacity coefficient is the property represented. During the past 10 years these charts have been used for predictions of liquid-vapor equilibria in a large number of practical engineering problems, and their reliability and utility have been demonstrated. The charts are reliable except when K-values more accurate than 5 percent are required, and when the pressure is within 50 psia. of the critical pressure of either phase, and except when the characterization factor of either phase is less than 11.4, or when either phase contains more than 30 percent of a polar compound, or when the pressure, temperature or molal average boiling point is so far outside the range of the charts as to preclude reliable extrapolation. It is the authors' belief that the charts described in the paper represent the most satisfactory compromise between simplicity and accuracy of any means now available for predicting liquid-vapor equilibria in mixtures of light hydrocarbons.

Phase Equilibria in Hydrocarbon Systems. Volumetric Behavior of the Nitrogen-Ethane System. H. H. REAMER, F. T. SELLECK, B. H. SAGE, AND W. N. LACEY. *Ind. Eng. Chem.*, **44** (1952), pp. 198-9.

Nitrogen is a component of the gases in many petroleum reservoirs and can be considered as a component of natural gas. Mixtures of nitrogen and paraffin hydrocarbons do not form ideal solutions at elevated pressure, and therefore a knowledge of the volumetric behavior of such mixtures is of industrial importance. The effect of temperature and pressure on the molal volume of three mixtures of nitrogen and ethane was experimentally studied. Measurements were made of the pressures up to 10,000 psi. over the temperature interval between 40° and 460° F. The results are in good agreement with the volumetric behavior of the components. The data, after smoothing, are presented in tabular and graphical form. The measurements reported, taken together with those from a similar study of nitrogen-methane, permit the estimation of the partial volumetric behavior of nitrogen with fair accuracy in a number of natural gases that are composed primarily of these two hydrocarbon components.

Solubility of Ethylene in Water. Effect of Temperature and Pressure. E. J. BRADBURY, DOROTHY MCNULTY, R. L. SAVAGE, AND E. E. MCSWEENEY. *Ind. Eng. Chem.*, **44** (1952), pp. 211-12.

Data were obtained at pressures running from 1 to 523 atmospheres for the solubility of ethylene in water at 35°, 55°, 75°, and 100° C. The results show an inversion around 75° C., where the solubility increases with increasing temperature. The results of the work indicate that ethylene deviates from an ideal gas; it therefore appears advisable to verify calculated solubilities by actual experimental work.

Manufacture: Processes and Plant

Chemical Engineering Unit Operations Review. *Ind. Eng. Chem.*, **44** (1952), pp. 21-94.

This is the seventh Unit Operations Review. The subjects covered are absorption and humidification, adsorption, centrifuging, crystallization, high temperature distillation, evaporation, solvent extraction, filtration, fluid dynamics, heat transfer, ion exchange, materials handling, mixing and size reduction. Increased activity is current in the fields of solvent extraction and ion exchange developments. The articles on each separate subject contain fairly extensive bibliographies that will be found useful for reference.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will be prepared and furnished by arrangement with the Leslie Laboratories.

Heat Transfer Between a Vertical Tube and a Fluidized Air-Solid Mixture. WILLARD M. DOW AND MAX JAKOB. *Chem. Eng. Progress*, **47** (1951), pp. 637-48.

The investigations reported dealt with steady state heat transfer from a vertical tube wall to a mixture of small solid particles and air. The work was undertaken to determine the main factors that affect the heat transfer and to gain an insight into its mechanism so that a correlation of the experimental data could be made. Tubes studied were two inches and three inches in diameter and were set vertically. The fluidized mixture consisted of particles of three solid materials, Aerocat, pitch coke and iron, suspended in an upwardly flowing stream of air entering at average velocities of ¼ to one ft./sec. Heat-transfer coefficients as high as 174 B.t.u./(hr) (sq. ft.) (°F.) were observed. A heat-transfer mechanism involving a narrow thermal layer next to the tube wall, a limited thermal mixing region at the bottom of the fluidized bed and a large thermal equilibrium region throughout the remainder of the bed was conceived. This concept was used as a guide for a dimensionless correlation of the data for mechanically smooth, dense-phase fluidization. It was observed that conditions of slugging and channeling have a marked effect on the rate of heat transfer.

Plate-Efficiency Correlation in Distilling Columns and Gas Absorbers. JU CHIN CHU, J. RICHARD DONOVAN, B. CLIFFORD BOSEWELL AND L. CHARLES FURMEISTER. *Jour. Applied Chem.*, **1** (1951), pp. 529-41.

The authors describe two methods for the estimation of plate efficiency in distillation columns and gas absorbers. The first, which is the more rigorous, deals with the correlation of local Murphree plate efficiency. A working formula is derived. Surface tension has no effect in determining plate efficiency, but does enter, together with density of liquid and vapor, slot width and height, temperature and pressure of the system, as a factor in the expression for the calculation of critical flow rate which divides flow into turbulent or streamline which, in turn, permits the choice of the right equation to calculate the bubble size which is an important factor in deter-

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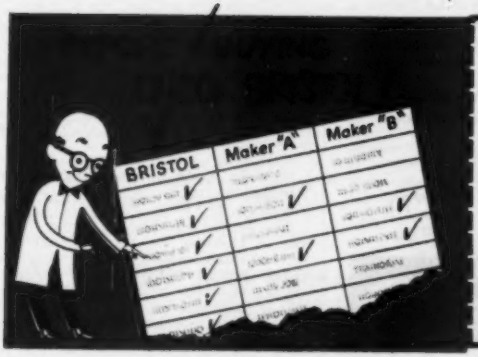

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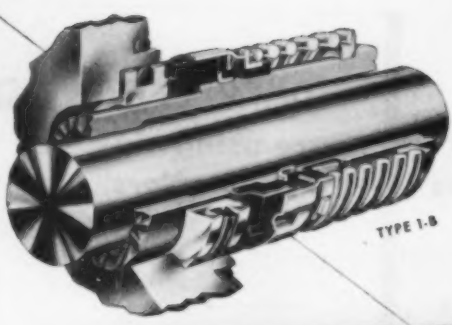

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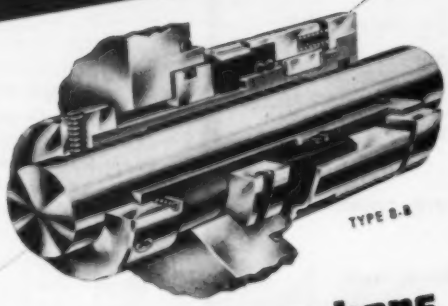

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mining plate efficiency. The molal ratio of liquid to vapor rate, L/V, is introduced as a term either in the conversion of local Murphree plate efficiency into over-all plate efficiency or in the calculation of actual number of plates using the plate-to-plate method with Murphree plate efficiency. The ratio L/V may also enter into a function as a correction factor for the bubble-size calculation if the column is operated at an extremely high value of the L/V ratio. The second method described correlates the overall plate efficiency with L/V ratio, effective submergence, relative volatility of the key components and viscosity of the feed. Two equations are developed which, although somewhat empirical, represent a convenient method for use in the computation of the actual number of plates in distilling columns or gas absorbers.

Distillation in a Multitube Wetted-Wall Column. E. E. Lindsey, J. M. Kiefer, and C. L. Huffine. *Ind. Eng. Chem.*, **44** (1952), pp. 225-31.

The authors studied a wetted-wall column comprising the outer surfaces of seven parallel tubes. The systems of methanol-water and trichloroethylenetoluene show that the wetted-wall column is somewhat less efficient than an equivalent packed column at any but the lowest reflux ratios. The pressure drop through the column, however, is low. It is indicated that the efficiency of the column might be improved by closer spacing of the tubes without serious sacrifice in pressure drop. It was concluded that the multiple tube column is of industrial interest largely in applications such as vacuum distillation, where pressure drop is of great importance.

Mass-Transfer Rates on Bubble Plates II. Results for Large Trays. J. A. Gerster, W. E. Bonnet, and Irwin Hess. *Chem. Eng. Progress*, **47** (1951), pp. 621-7.

The first part of the paper appeared in the October, 1951, issue of Chemical Engineering Progress. The importance of measuring and correlating gas and liquid efficiencies separately was emphasized. In the present paper the experimental test unit is described and further data are presented showing that the fundamental factors of plate design and operation affect gas-film efficiencies and liquid-film efficiencies in an entirely different manner, which emphasizes the importance of separating over-all efficiencies into their gas- and liquid-phase components for purposes of correlation, prediction, or extension of the results. Combination of the single-film efficiencies to predict over-all efficiencies was shown to be accurate for a binary system for which the physical properties at distillation temperatures and pressures were known. A bibliography of 19 references is included.

How To Train Refinery Engineers in Distillation. Ju Chin Chu. *Jour. Inst. of Petroleum*, **37** (1951), pp. 605-32.

The author refers to the acute shortage of chemical or refinery engineers with adequate and up-to-date training in distillation. The present collegiate training is frequently inadequate in its coverage of distillation to permit the graduate to solve practical problems. In the presentation of the subject of distillation

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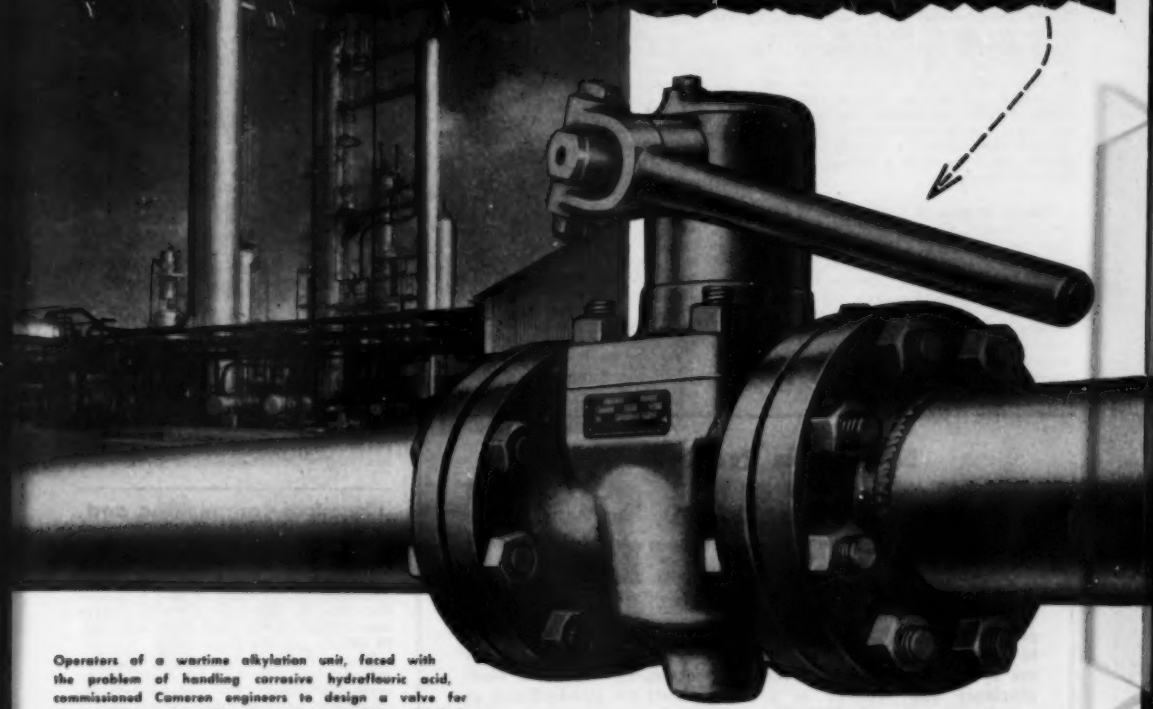

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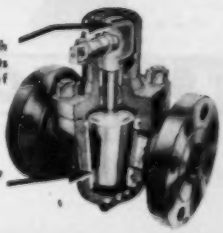

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questions arise, such as: How can a well-rounded graduate course in distillation be conducted? Where and how can the necessary materials be obtained for such an advanced course? The author writes the present paper in the hope of meeting the current need of both academic institutions and refineries in their program of training engineers in the subject of distillation. The first section of the paper is devoted to a bibliographic guide to the literature of distillation. The second section of the paper concerns itself with the subject matter that should be considered in a distillation course. This includes fundamental data, vapor-liquid equilibrium, simple distillation, continuous distillation, design and performance of continuous plate columns, batch distillation, packed columns, azeotropic and extractive distillation, commercial distilling columns and accessories, operating technique and instrumentation, and laboratory and molecular distillation. The article concludes with a bibliography of 390 references.

Solvent Drying. R. J. Mitchell. *Chem. Eng. Progress*, **47** (1951), pp. 649-53.

In the operation of processes using methyl ethyl ketone or methyl ethyl ketone-benzene mixed solvents, it is frequently desirable to control the amount of water in the solvent and, in some instances, to maintain the solvent practically water-free. The author presents a method for the distillation drying of such solvent mixtures as are used in the wax-manufacturing processes. A design procedure is given employing a modification of the McCabe-Thiele graphical method. Distillation of the three-component system methyl ethyl ketone-benzene-water is divided into two steps: water stripping at constant benzene composition, and benzene enrichment of a water-saturated solvent. The equilibrium data for the ternary systems are given. Operating data taken from a commercial drier indicate plate efficiencies of 30 percent for the water-stripping section and 80 percent for the benzene enrichment section. The use of such a drier in the solvent-recovery system of a wax-deoiling plant is discussed.

Gas Mixing in Beds of Fluidized Solids. E. R. Gilliland and E. A. Mason. *Ind. Eng. Chem.*, **44** (1952), pp. 218-24.

The results obtained in the application of the fluidizing procedure to reactions is influenced by the flow pattern of the fluid through the suspended solids. The pattern of gas flow was studied by means of helium tracer technique. Small glass beads and petroleum catalysts were used as typical solids. The back mixing and residence time of gas in the bed was measured experimentally. The results show that back mixing does occur, but that the non-uniform flow of the gas is the more important. Non-uniform flow can reduce the effectiveness of the contact between the gas and the solids and, for those reactions that require high percentage of conversion, it may be necessary to use a reaction volume several times that required if the flow of the gas were uniform.

Extraction of Sulfur from Sulfur Ores. N. P. Ekonomopoulos. *Ind. Eng. Chem.*, **44** (1952), pp. 105-6.

The object of the work was to extract sulfur from brittle tufaceous sulfur ores, from which the recovery of sulfur by other methods is not practicable. Gas oil was used as an extracting medium at a temperature of 120° C. and the sulfur contained in the ores was completely recovered in substantially 100 percent purity. The method can be applied not only to the extraction of sulfur from the ores, but also to the purification of sulfur containing such contaminating elements as arsenic, tellurium, and selenium. In the extraction the temperature must not exceed 140° C. in order to avoid reaction between the sulfur and the oil and consequent evolution of hydrogen sulfide. The miscella from the extraction is cooled to about 80° C. when the sulfur starts to separate in finely crystalline form and when the temperature is further reduced to about 30° C., complete precipitation of the sulfur takes place. Gas oil can then be separated by filtration or decantation from the sulfur which has been deposited in the form of a fine powder at the bottom of the tank. The gas oil is then reused. The sulfur is washed with water to separate it completely from any gas oil which it may retain. The loss of gas oil in a complete cycle is only approximately 1.3 percent.

Cast Alloy Reference Sheet. N. S. Mott. *Chem. Eng. Progress*, **47** (1951), p. 654.

The author presents a cast alloy reference sheet for a corrosion resistant low carbon 25 percent chromium 12 percent nickel alloy, which has improved resistance over 18-8 because of the higher chromium and nickel contents. Machining, heat treating and welding of the alloy are described and its corrosion resistance to a long series of acids, alkalies, and other substances is given.

Chemical Composition and Reactions

The Synthesis and Properties of 1,1,2-Trimethylcyclopropane. Robert G. Kelso, Kenneth W. Greenlee, John M. Derfer and Cecil E. Boord. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 287-92.

The authors first prepared 1,1,2-Trimethylcyclopropane by a previously known synthesis, namely, the reaction between 2,4-dibromo-2-methylpentane and zinc in aqueous propanol at 0° C. However, the synthesis was done on a pilot plant scale, high efficiency distillation was used, and a thorough study of the reaction and the reaction products was made, thus permitting the proposal of logical reaction mechanisms. 1,1,2 - Trimethylcyclopropane comprised 68 percent of the hydrocarbon mixture obtained in 67 percent yield. 2-methylpentane, 2-methyl-1-pentane and 2-methyl-2-pentane were also identified as definite by-products, while 4-methyl-2-pentene was present in small quantity. Other syntheses of 1,1,2-trimethylcyclopropane were also studied. Reaction mechanisms are proposed. Separation of relatively pure 1,1,2-trimethylcyclopropane permitted the accurate determination of the common physical properties and a study of the stability of the hydrocarbons. The results of this work are reported.

The Thermal Decomposition of Cyclopentane. Don W. Vanas, Nancy M.

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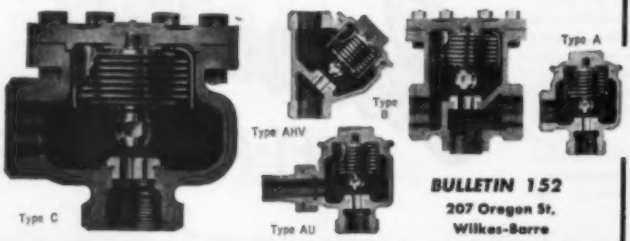

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March ★ One of a Series of Interest to the Petroleum Industry ★ 1952

"New Look" for Du Pont Quarterly Motor Gasoline Survey

Just as gasolines are tailored to meet seasonal driving needs, the 1952 covers for Du Pont's Quarterly Motor Gasoline Surveys have been redesigned to portray the season in which they appear. This change is intended to make for quicker identification of any desired issues.

The January 1952 cover showed a snow-flaked winter service station scene. In the background was a map of the United States and Canada, indicating the extensive territory covered by the survey.

The April issue (due the week of April 21st) will carry out the seasonal theme with a spring scene.

Du Pont Historical Highlights

When the Du Pont Company was founded a century and a half ago, Federal Government income came almost entirely from customs duties. Taxes on the cost of manufacturing were almost unknown. Income, excess profits, franchise, sales, use, inheritance and social security taxes did not exist.

State taxes were levied chiefly on property and the State of Delaware's entire tax collection in 1802 amounted to less than $15,000 and total Federal income was $15 million.

Recent additions to the Du Pont Experimental Station alone cost more than $30 million, or twice as much as the entire Federal income in the year the Company was founded. And even the new Du Pont Petroleum Laboratory facilities would have taken a substantial bite from Uncle Sam's 1802 income if that gentleman had been required to pay the bill.

New Planning Staff will Coordinate Du Pont Facilities to Meet Petroleum Industry Needs

Because of the tremendous growth of the petroleum industry during the past decade, Du Pont is expanding its efforts to anticipate, as well as meet, the industry's petroleum chemicals requirements.

PLANNING MANAGER

T. BALDWIN PRICKETT was recently appointed Planning Manager of the Du Pont Petroleum Chemicals Division.

Mr. Prickett's previous activities and experience as refinery technologist for the division make him well qualified to take over his new duties of coordinating Du Pont's facilities to meet current and future needs of the petroleum industry.

His broad experience in chemical manufacturing includes work with the National Aniline and Chemical Company and the Pennsylvania Salt Manufacturing Company.

In 1931, Mr. Prickett joined Socony-Vacuum Oil Company and became assistant plant engineer in charge of initial development of the Houdry catalytic cracking process. He later became associated with the Houdry Process Corporation and affiliates as vice-president.

Just before he came to Du Pont in 1946, Mr. Prickett was in charge of commercial development of the Houdry process. He also directed the engineering, plant operations, and catalyst manufacturing activities of the Houdry Corporation.

To activate this program, the Du Pont Petroleum Chemicals Division recently organized a full-time planning staff.

Among the aims of this group will be long-range plans to assure ample supplies and convenient deliveries of all gasoline additives, plus the consideration of new product development to meet specific industry needs. These activities will complement the work of the Du Pont engineering laboratories and technical, automotive and other Du Pont petroleum industry service groups.

BROAD INDUSTRY STUDIES

To help keep the Du Pont Company informed on the growth and trends of the industry it serves, the planning group will base its studies not only on tetraethyl lead production, but on the broad foundation of all other factors contributing to supply and demand trends in the petroleum industry. Such a project calls for comprehensive studies of transportation facilities, technical refining developments and sources of supply for raw materials. Automotive and aviation engineering trends will be considered, too.

Although extremely broad in scope, the program is expected to result in many practical benefits for refiners. And, as the only manufacturer of a complete line of gasoline additives, Du Pont is keenly interested in continuing to serve the industry on as comprehensive a scale as possible.

To help accomplish the goal, the Du Pont Petroleum Chemicals Division is supported by research facilities that rank among the world's largest. Cooperating with these facilities on the development of new products to meet petroleum industry needs will be an important function of the new planning group. And the group will be constantly working to make Du Pont petroleum chemicals more exactly tailored to your specific refinery needs.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

New Du Pont Book Helps Small Refineries Set Up Safety Programs

"How can we set up an effective safety program in our refinery?"

That was a question frequently asked Du Pont by refiners operating plants with up to 2,000 employees. With a long established safety history and a keen interest in furthering safety throughout industry, Du Pont is regarded as a logical source of help in safety planning.

As a result of many requests, Du Pont recently published "Safety for the Small Refinery"—a 42-page book prepared with the help and cooperation of the National Safety Council. It tells, step by step, how to set up an effective refinery safety program and, more important, how to use the wealth of safety material available to refiners.

MANAGEMENT FUNCTION

While the foreman is a key man in any good industrial safety program, safety is also an important *function* of *every* job. And most important of

all, the safety program must gain its driving force from the active participation and interest of top management.

In this connection, the new Du Pont book outlines a basic safety philosophy around which refinery management can build its own policy. It also contains a suggested plan for setting up a refinery safety council of executives, and a safety committee drawn from plant personnel.

The book lists a wide range of general safety material available from the National Safety Council and the American Petroleum Institute. Typical monthly and yearly refinery safety programs are outlined in detail—on a day-by-day basis.

A copy of "Safety for the Small Refinery" is available to you through the nearest Du Pont Petroleum Chemicals Division district office.

DU PONT TANK CLEANING CLINIC GOES ON TOUR

Based on the request of a large oil company, the Operations Group of the Petroleum Chemicals Division has set up a discussion clinic on the hazards connected with entry of leaded storage tanks.

B. GARDNER CRANE, Director of the Du Pont Petroleum Chemicals Division Operations Group, conducting a typical refinery safety clinic.

Headed by B. Gardner Crane who directs the Du Pont Operations Group and Dr. Stewart L. Rankin, chief medical advisor to the Petroleum Chemicals Division, the clinic recently completed a tour of five refineries operated by the company requesting the service. The meetings met with enthusiastic approval, and the Operations Group is now prepared to take the clinic on tour for other refiners interested in the service.

Essentially, the clinic is a safety review program for terminal managers and group leaders directly concerned with tank cleaning. Informal, yet broad in scope, it discusses the main problems and precautions involved in cleaning leaded storage tanks.

COMPREHENSIVE PROGRAM

Basically, the clinic program covers the following:

1. Toxicity of tetraethyl lead compounds.
2. Order of magnitude of TEL hazards in leaded gasoline storage tanks.
3. Description of lead-free tank for purpose of entry without protective equipment . . . for both "cold" and "hot" work. The exceptions are also covered.
4. The mechanics of tank cleaning, including sludge disposal problems.
5. Description of use and limitations of Du Pont Lead-in-Air Analyzer.
6. Emergencies in handling tetraethyl lead compounds.
7. Question and answer session.

The program is quite flexible and can be readily varied to meet individual plant or company needs.

For information regarding the Du Pont Tank Cleaning Clinic, get in touch with your Du Pont Petroleum Chemicals Division district office.

Literature—Movies Available

Here is a partial listing of the movies, bulletins, reports, booklets and aids available to you through the nearest Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery – A 42-page book on how to set up an effective small refinery safety program . . . . . Serial A-2848

Tank Talk – A 52-page, easy-to-understand safety booklet for tank-cleaning crews . . . . . Serial A-1134

Prints of the following Du Pont films are available to oil companies for training and public relations purposes. They may be borrowed or purchased.

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

What makes a Gasoline Good – An 18-minute cartoon movie in color. Presents, in easy-to-understand form, the story of how high quality gasoline is made. Ideal for dealer training meetings.

In addition, Du Pont makes available a special library of films of particular interest to the petroleum industry.

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A-3149

Printed in U. S. A.

LODGE AND W. D. WALTERS. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 451-5.

Previous work has shown that the thermal decomposition of cyclopentane at approximately 600° C. gives largely cyclopentadiene and hydrogen, plus propylene and ethylene. The authors further studied the reaction in the neighborhood of 555° C. The addition of nitrogen, hydrogen or a small amount of nitric oxide did not change the rate of pressure rise in the initial stages of the reaction. In the presence of a mixture of products, or added ethylene, propylene or cyclopentadiene, an increase in the rate of reaction is observed. Also small amounts of diallyl or allene accelerate the rate. Analyses for the products cyclopentadiene and hydrogen indicate that the dehydrogenation of cyclopentane is accelerated by the addition of ethylene or propylene.

Selective Hydrogenation of Polyolefins with Metal Sulfide Catalysts in the Liquid Phase. R. J. MOORE, R. A. TRIMBLE AND B. S. GREENSFELDER. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 373-5.

Because of the successful development and application of metal sulfide catalysts for commercial high temperature vapor phase hydrogenation and dehydrogenation, the use of catalysts of this type with sufficient activity for liquid phase reactions at low to moderate temperatures was studied. In the range of temperature 100° to 200° C., metal sulfides, notably those of nickel and molybdenum, are active and selective for the hydrogenation of certain polyolefins to monoolefins in the liquid phase. However, they are practically inactive for the hydrogenation of monoolefins or the benzene ring. The metal sulfide catalysts retain their activity in the presence of as much as one percent mercaptan or alkyl sulfide. The authors present evidence which indicates that the hydrogenation proceeds through the conjugated form of the polyolefin, with preliminary catalyzed isomerization of nonconjugated double bonds to the conjugated form when this is structurally possible.

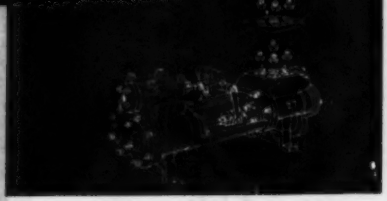
By-Products of the Thiophene Synthesis. PHILIP D. CAESAR AND PETER D. BRANTON. *Ind. Eng. Chem.*, **44** (1952), pp. 122-5.

The article deals with the composition of the tar that is produced as a by-product in the reaction of n-butane and sulfur for the production of thiophene and also with the two compounds that comprise the bulk of the lower boiling components of the tar. The compound 3-thiophenethiol was found and to the extent of about one pound of this compound for every four pounds of thiophene. A second compound isolated was tentatively identified as 3,4-thiolanedithione. In total, about 40 percent of the by-product tar was converted into useful products. Tar is a possible large scale source of two new and versatile compounds of high sulfur content that may be of interest to the rubber, dye, and pharmaceutical industries. A bibliography of 21 references is included.

Hydrogen-Deuterium Exchange Activity of Catalysts. V. C. F. HOLM AND R. W. BLUE. *Ind. Eng. Chem.*, **44** (1952), pp. 107-13.

All catalysts used for hydrogenation

4 WAYS TO CUT THOSE PUMP REPAIRS



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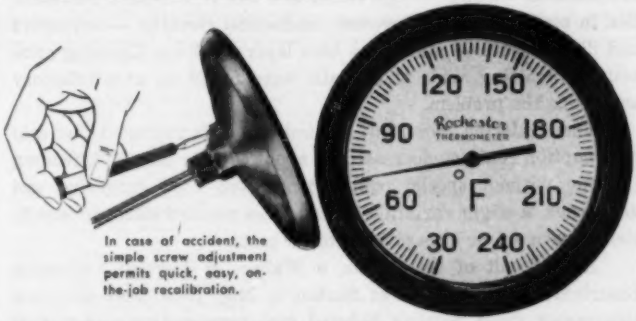

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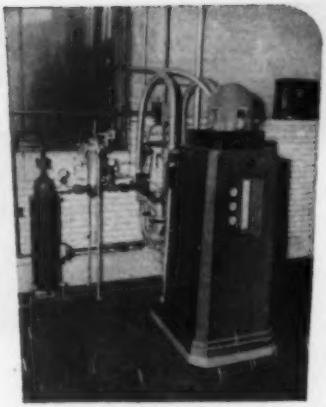

W&T Chlorinator Installation at Saxton Station

A W&T CHLORINATOR

In winning their battle against condenser slime at the Saxton Generating Station, Pennsylvania Electric Company, in their company publication, called the Wallace & Tiernan Chlorinator their "Secret Weapon."

Here's what happened before chlorine was tried. Experience showed even a small accumulation of slime caused a one inch loss in condenser vacuum — equivalent to a five to ten per cent reduction in plant efficiency. Frequent mechanical cleaning — expensive and disagreeable — still left a thin layer of slime. Cleaning compounds involving acids and alkalis were found an unsatisfactory answer to the problem.

Then Chlorine was tried! Preliminary tests indicated that coal consumption could be decreased by about $75 per day. *But*, feeding chlorine without special equipment proved both expensive and dangerous. A slight variation in feed rates resulted either in insufficient treatment or excessive chemical costs.

As a result of these tests, a Wallace & Tiernan Automatic Chlorinator was installed at Saxton in May 1949. This precision chlorinator made possible reduced coal consumption and virtual elimination of mechanical tube cleaning — the reasons why a W&T Chlorinator is Saxton's "Secret Weapon."

Hundreds of power plants have had benefits similar to those at the Saxton Station. For information on how you can solve your slime problems, contact your nearest W&T Representative or write to:

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or dehydrogenation reactions have one characteristic in common—they present a surface that is favorable either for the dissociation of hydrogen molecules into atoms or the recombination of atoms into hydrogen molecules. In the present work the rate of hydrogen-deuterium exchange was measured for 12 commercial and 13 specially prepared catalysts. The reaction $H_2 + D_2 = 2$ HD is believed to proceed via dissociation of hydrogen molecules and recombination of adsorbed atoms; and it should, therefore, provide information about the relative activity of catalysts. The range of catalytic activity studied was about 1,000,000 from synthetic silica-alumina catalysts with low activity to diatomaceous earth-mounted nickel catalysts with high activity. All of the catalysts studied except chromia catalysts gave linear plots of log k vs. 1/T. Energies of activation ranged from 2200 for reduced tungstic oxide to 13,800 for a chrome-iron catalyst. Iron and zinc oxide were studied with special care because of anomalies reported by other investigators. However, none were found as regards H/D exchange. The addition of potassium reduced the activity of iron catalysts sharply until about 0.3 percent potassium was added, after which there was little further effect. The reaction $H_2 + D_2 = 2$ HD appears to be a first-order reaction. A bibliography of 18 references is included.

Products: Properties, Utilization and Analysis

Asphalt, a Colloidal Material. R. N. Traxler and J. W. Romberg. *Ind. Eng. Chem.*, **44** (1952), pp. 155-8.

The realization that asphalts are colloids stimulated the understanding of their properties. Only when asphaltic bitumen is studied as a colloid is real progress made toward an understanding of its behavior. In general, asphalts can be classified as gel or sols with every degree of gradation occurring between these two extremes. The authors' investigation was made to correlate variation in the physical properties with colloidal characteristics. Solubilities in organic solvents, microscopical examination, rheological properties, and dispersion and flocculation of asphaltenes by petrolenes have been employed to distinguish asphalts of different colloidal characteristics. The authors present data that show that correlations exist between colloidal characteristics and physical properties that determine the usefulness of asphalts in service.

Determination of Thiols in Hydrocarbon Gases. Edgar W. Ellis and Thomas Barker. *Analytical Chem.*, **23** (1951), pp. 1777-9.

The wide use of liquefied petroleum gases and other gaseous fuels has resulted in state legislation requiring that the fuel gases contain some minimum concentration of odorous substance in order that leaks can be detected. The customary practice is to add volatile thiols (mercaptans) directly to the gas before it is sold. It is obvious, therefore, that a dependable method is needed for the determination of thiols in fuel gases.

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CONDENSER AND HEAT EXCHANGER TUBE EDITION

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ALUMINUM BRASS GIVES GOOD SERVICE Under Severe Operating Conditions

Continuous operation associated with higher operating efficiency is putting a heavier burden on condenser and heat exchanger tubes. Alloys which gave a good account of themselves in former years when equipment was operated intermittently well within design velocities, are failing under the grueling effect of constant operation.

It is well known that petroleum refinery units are kept going 'round the clock month after month until breakdown of individual pieces of equipment makes it more practical to shutdown the unit for major overhauling. Likewise in the power generating field, the accelerated demand for power in the last decade has in many cases not only utilized standby equipment going at full schedules but has often called for power output beyond design capacity.

This explains why alloys such as Admiralty, which gave such excellent performance in former years in certain condenser installations, often fail prematurely when used for retubing under present severe operating conditions.

On the other hand, such alloys as aluminum brass (78% copper, 2% aluminum and 0.03% arsenic, balance zinc) have been growing in importance and are replacing Admiralty in many installations. Aluminum brass is inherently more resistant to corrosion than Admiralty from both slow and rapidly moving sea water as well as polluted waters in harbors and rivers that are contaminated by sewage and industrial wastes. Aluminum brass, when replacing Admiralty, generally gives a better account of itself particularly where inlet-end corrosion or impingement corrosion has been a serious problem.

It has also been found that higher velocities of circulating water, either fresh or salt, are prone to attack Admiralty more severely than aluminum brass. It must be borne in mind that it is necessary to use arsenic as an inhibitor of dezincification in aluminum brass as well as in Admiralty to assure longer service life.

In common with Admiralty, aluminum brass has good corrosion resistance to sulphur compounds found in various petroleum liquids and gases.

The table giving comparative physical and mechanical properties of arsenical aluminum brass versus arsenical Admiralty should be helpful to design engineers. (8022)

COMPARATIVE PHYSICAL AND MECHANICAL PROPERTIES OF ARSENICAL ALUMINUM BRASS AND ARSENICAL ADMIRALTY

ANALYSIS	Aluminum Brass 54	Arsenical Admiralty 30
Copper	77.0	71.0
Tin		1.05
Aluminum	2.1	
Arsenic	0.03	0.03
Zinc	balance	balance
MECHANICAL PROPERTIES		
Tensile Strength—Soft	50,000	45,000
Yield Strength—Soft	18,000	15,000
Elongation % in 2" Soft	55	65
Contraction in Area % Soft	72	71
Rockwell Hardness—Soft	F77	F75
Elastic Limit—Soft	16,000	18,000
Modulus of Elasticity in Tension x 10^6	16	16
PHYSICAL CONSTANTS		
Density @ 68°F lbs./cu. in.	.301	.302
Specific Gravity	8.33	8.53
Melting Pt. °F Liquidus	1780	1720
Solidus	1710	1650
THERMAL CONSTANTS		
Coefficients of Thermal Exp. per °F from 68°F to 572°F x 10^{-6}	10.3	11.2
per °C from 20°C to 300°C x 10^{-6}	18.5	20.2
Thermal Conductivity at 68°F BTU/sq. ft./ft./hr./°F	58	64
Calories/cm^2/cm/sec/°C	0.24	0.26
Thermal Capacity (spec. heat) @ 68°F BTU/lb./°F	.09	.09
@ 20°C cal./gm./°C	.09	.09
ELECTRICAL CONSTANTS		
Resistivity ohms/mil foot @ 68°F (annealed)	45	42
Conductivity % IACS @ 68°F (annealed)	23	25
(annealed) megmho-cm^2 @ 20°C	0.133	0.145
Resistivity, micro-ohm centimeters @ 20°C (annealed)	7.5	6.9
Color	Yellow	Yellow
FABRICATION PROPERTIES		
Cold working	Excellent	Excellent
Hot working	Fair	Fair
Hot working Temp. °F	1400-1600	1200-1450
Hot Working Temp. °C	750-875	650-800
Machinability rating	30	30
Soft soldering	Good	Excellent
Silver brazing	Good	Good
Oxyacetylene welding	Good	Good
Carbon arc welding	Good	Fair
Resistance welding	Good	Fair
Polishing	Good	Good
Annealing Temp. °F	800-1100	800-1100
SPECIFICATIONS		
A.S.T.M	B-111-50	B-111-50
U. S. Navy		44T7g
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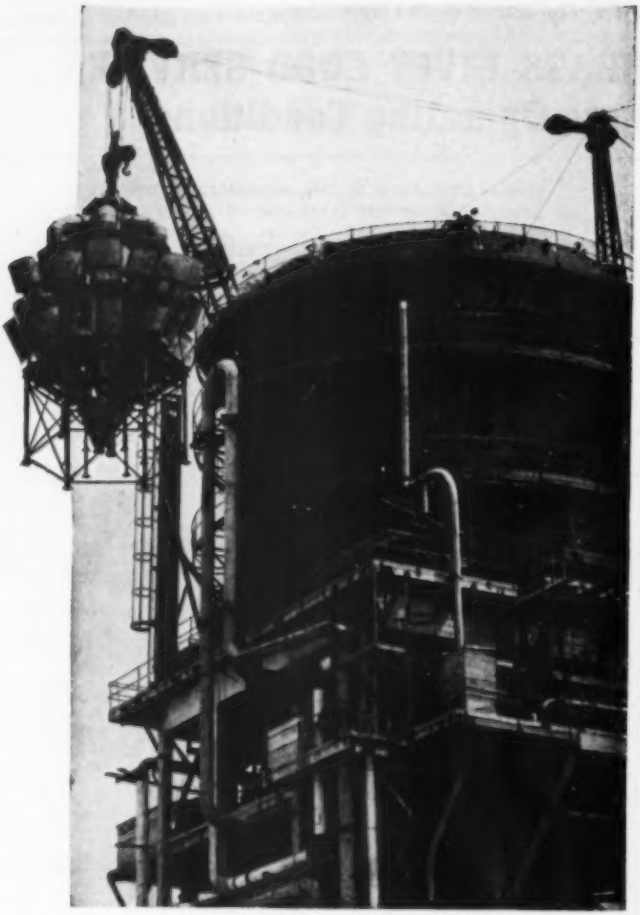

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DUST COLLECTION

MANUFACTURING IN UNITED STATES AND CANADA FOR SHIPMENT THROUGHOUT NORTH AND SOUTH AMERICA

The authors describe a method requiring no complicated or specially built apparatus, and that uses reagents requiring infrequent standardization. The method is based on the oxidation of the thiols in a measured volume of gas using excess cupric acetate-acetic acid reagent. The excess of cupric ion is back-titrated with sodium thiosulfate in the presence of potassium iodide and starch. The results are reproducible and accurate to within 0.2 grains of thiol, calculated as sulfur, per thousand cubic feet of gas. The procedure is also useful in analyzing the performance of scrubbers for removing thiols in refinery gas streams.

Aromatic Molecular Weight Distribution and Total Aromatic Content. Determination by Mass Spectroscopy. H. E. LUMPKIN AND B. W. THOMAS. *Analytical Chem.*, **23** (1951), pp. 1738-40.

The rapid and accurate determination of total aromatics and aromatic molecular weight groups has become important in refinery process control and for the evaluation of pilot plant results. Methods involving distillation, silica gel absorption, acid absorption, and specific dispersion are laborious. However, the mass spectral patterns of the aromatic compounds are sufficiently different from those of other compounds in hydrocarbon solutions to permit the determination of the aromatics in complex mixtures. The authors describe a method which requires 45 to 60 minutes and has an accuracy of ±1 percent for different aromatic molecular weight groups and also for total aromatic content of the solution. The molecular weight distribution determination particularly effects a considerable saving of time, as it avoids the distillation step which must be employed with conventional analytical methods to obtain the same information.

Spectrographic Analyses of Cracking Catalysts. Determination of Magnesium and Zirconium. LEON W. GAMBLE. *Analytical Chem.*, **23** (1951), pp. 1817-20.

The purpose of the work reported was to study rapid methods for the determination of magnesium and zirconium in connection with catalyst development problems. Conventional chemical methods are time consuming, particularly if the separation from calcium is made. The author reports a spectrographic method that is applicable to a fairly wide range of magnesia content, namely 0.2 to 12 percent magnesium oxide and that requires only 2.5 hours' time as compared to approximately 16 hours for the conventional chemical method. The procedure is applicable to the analysis of clay as well as to synthetic catalysts such as silica-magnesia, silica-alumina, or mixtures of them. The zirconium method is useful in the range 0.01 to 5 percent zirconium oxide. The results of the spectrographic determinations are in fair agreement with those obtained chemically. The effect of large amounts of alumina on the determination of zirconium is discussed.

Spectrographic Determination of Lubricating Oil Additive. J. P. PAGLIASSOTTI AND F. W. PORSCHE. *Analytical Chem.*, **23** (1951), pp. 1820-3.

Numerous additives, such as pour point depressants, viscosity-index im-

provers, detergents, oxidation inhibitors, corrosion inhibitors, antifoam agents, and color improvers are used in lubricating oil. These addition agents may contain such elements as phosphorus, potassium, barium, calcium and zinc. Chemical methods for the determination of these elements are time-consuming and tedious. The authors developed a spectrographic method for the direct and rapid determination of these elements in lubricating oils. An important feature of the method is the use of the magnesium salt of 2-ethylhexoic acid as a spectrochemical buffer and of nickel as an internal standard. Presence of each additive element being determined has no effect on the determination of the others. Nine metals-containing additives, seven different base oils, and twenty-two compositions of oils and additives were studied without finding a combination for which the method failed to work. The viscosity of the oils has no effect on the analysis. The procedure is fast, simple, and accurate, and has been in successful use in plant-control work for a period of a year.

Treasury Cites Tide Water For Bond Participation

The Tide Water Associated Oil Company, Eastern Division, has been presented a special U. S. Treasury Department citation for outstanding achievement in promoting employe purchase of U. S. Defense Bonds through the Payroll Savings Plan.

Frank B. Mitchell, director of Payroll Savings, Treasury's U. S. Savings Bond Division for New York, noted that the Eastern Division had enrolled 2080 of its employes in the Payroll Savings Plan, a participation of over 50 percent.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Triphenyl antimony
N,N,N',N'-Tetraethyl-m-phenylene diamine
Tetraallylsilane
Mercury dimethyl
1-Hydroxymethylcyclobutanol-1
Formethyl-2-hexanone
Divinyl sulfone
Cyclobutene
Dihydrobenzoic acid
Decamethylenediamine
0,3,3-Bicyclooctane
2-Amino-1-hydroxynaphthalene
1,5-Dichloronaphthalene
Methylenecyclobutane
5-Methyl-3-hexanone
Purpurin sulfonate
Piperonylic acid
1,7-Dimethylnaphthalene
2,7-Dimethylnaphthalene
o-tert.-Butyl toluene

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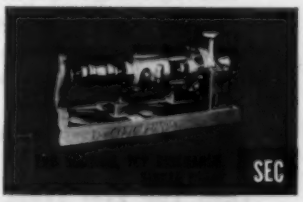

✔ **To the Owner of the plant**

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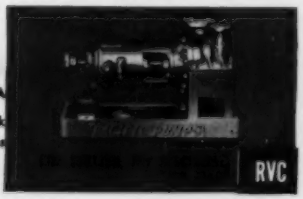

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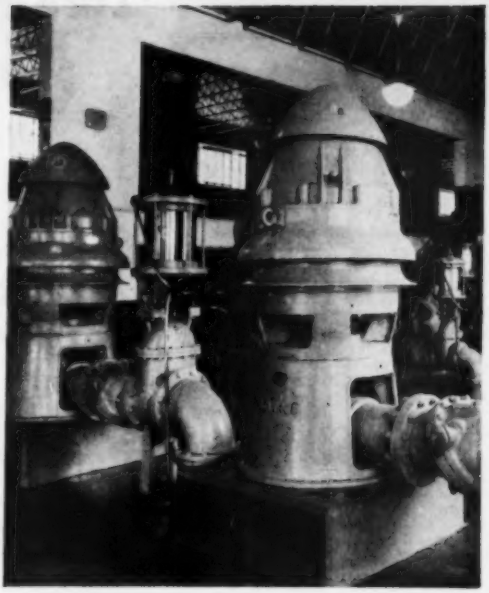

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, January 2, 9, 16 and 23, 1952)

REFINING

U.S.P. 2,580,750. Solvent Extraction of Oxygenated Organic Compounds. H. W. Fleming to Phillips Petroleum Company.

Details are claimed of a method of resolving by extraction a normally liquid hydrocarbon phase from a Fischer-Tropsch synthesis and containing hydrocarbons and oxygenated compounds. Ethylene glycol is employed as the extractant.

U.S.P. 2,580,881. Stabilized Petroleum Products and Stabilizing Compositions. C. B. Biswell to E. I. du Pont de Nemours and Company.

A petroleum product contains 0.0001-2 percent of an equimolecular carboxylic acid salt of a 1-(ortho-hydroxy-arylidene)-aminoguanidine in which the arylidene group is of the benzene series. The carboxylic acid shall contain at least 2 C atoms and 1-2 carboxyl groups. The additive stabilizes the petroleum product against oxidation and deterioration.

U.S.P. 2,581,064. Treating Oil with Sulfur Trioxide. F. M. Archibald to Standard Oil Development Company.

Petroleum distillates are treated for refining them with SO_3 in a series of stages in a special manner, in order to obtain a sludge or precipitate which may readily separate.

U.S.P. 2,581,065. Method of Purifying Isobutylene by Sulfuric Acid Extraction. W. A. Arnold to Standard Oil Development Company.

A C_4-hydrocarbon stream containing isobutylene, n-butenes, butanes and butadiene is treated with an acid to form an isobutylene-acid extract. Tert. butyl alcohol is added to the extract while under a pressure of 80-150 psi. The pressure is then reduced to 1-14 psi. in order to remove from the extract the physically dissolved and mechanically entrained C_4-hydrocarbons other than isobutylene.

U.S.P. 2,581,088. Fractionation of Gaseous Mixtures. L. D. Etherington and H. W. Scheeline to Standard Oil Development Company.

A mixture of normally gaseous hydrocarbons is passed into a fractional distillation zone which has at least two extraneously controlled heating media below the point of feed inlet maintained at different temperature levels. The thermodynamic efficiency of heating is increased thereby.

U.S.P. 2,581,117. Treatment of Cracked Naphthas with a Hypochlorite Followed by an Alkali Sulfide. R. M. Love to Standard Oil Development Company.

A cracked hydrocarbon is first contacted with a hypochlorite solution and then with an aqueous alkali metal sulfide solution. The stability of the naphtha is improved by the latter treatment.

U.S.P. 2,581,344. Purification of Distilled Coke-Oven Benzene by Distillation with Added Hydrocarbons Material. J. R. Anderson to Koppers Company, Inc.

Coke-oven benzene containing a small amount of non-aromatic hydrocarbon impurities higher boiling than benzene and inseparable therefrom by simple distillation is fractionally distilled with the addition of non-aromatic hydrocarbons boiling between 75-85° C. in an amount in excess of that required for azeotrope formation with benzene.

U.S.P. 2,581,398. Method for the Separation of Alpha-Methyl Naphthalene from Beta-Methyl Naphthalene by Azeotropic Distillation. J. Feldman and M. Orchin to the U. S. Secretary of the Interior.

A 2-amino-3-methyl pyridine entrainer is added to a mixture of alpha- and beta-methyl naphthalene. In distilling the resulting mixture at reduced pressure an azeotrope is formed with the beta-isomer so that the two isomers can be separated.

U.S.P. 2,581,441. Solidified Nonexplosive Hydrocarbon and Process for Producing Same. R. Raab to The Glenn L. Martin Company.

A liquid hydrocarbon fuel is dispersed in a solidifying composition containing sodium alginate, dextrine, and sucrose. Pellets are formed from the solidified fuel. The solidified pellets, in contrast to the liquid hydrocarbon fuel, are non-explosive.

U.S.P. 2,581,560. Refining of Synthetic Hydrocarbon Mixtures. R. V. Shankland, S. E. Shields, and E. W. Thiele to Standard Oil Company (Indiana).

An instable, badly-smelling synthetic mixture of hydrocarbons of the gasoline boiling range and organic oxygen compounds is contacted with a silica alumina gel catalyst of special composition at a temperature of 625-725° F. while avoiding cracking. A product of good color and stability toward oxygen is obtained.

U.S.P. 2,582,148. Method of Recovering Desirable Liquefiable Hydrocarbons. H. M. Nelly, Jr., to J. F. Pritchard and Company.

Gas from a natural gas producing formation is flowed under pressure to the earth surface and precooled at this pressure to effect stripping of the gas of desirable liquefiable hydrocarbons. The stripped gas is expanded to a lower pressure and refrigerated at this pressure to effect substantial condensation. The liquefied stripped gas is pumped to the formation at a pressure higher than that of the hydrocarbons in this formation, and passed in heat exchange relation with the gas flow prior to extraction of the desirable liquefiable hydrocarbons.

U.S.P. 2,582,192. Diesel Fuel Oil. G. H. Denison, Jr., to California Research Corporation.

A diesel fuel oil contains a minor proportion of reduced petroleum nitrogen bases comprising a homologous mixture of heterocyclic secondary amines. This mixture is obtained by extracting nitrogen-base-containing petroleum hydrocarbon oils with dilute mineral acid. The water-soluble salts obtained therein are neutralized and reconverted to crude nitrogen bases which are hydrogenated at elevated temperature and pressure in the presence of a sulf-active hydrogenation catalyst. The additive inhibits gum formation in the diesel oil.

U.S.P. 2,582,197. Solvent Extraction Process. C. J. Egan to California Research Corporation.

A mixture of normally liquid hydrocarbons boiling below 550° F. and containing a minor proportion of branched chain hydrocarbons, e.g., a mixture of aromatic and non-aromatic hydrocarbons, is contacted in the liquid phase with a perfluorocarbon having 3-12 C atoms. The solvent extract obtained contains predominantly the branched chain parffins.

U.S.P. 2,582,415. Adsorption Process for the Separation of Hydrocarbons. William H. Claussen to California Research Corporation.

Hydrocarbons are separated by selective adsorption in a continuous process in which adsorbent is passed as a solid flowing column through an adsorption zone; withdrawn adsorbent containing hydrocarbon extract is passed to a separator where it is countercurrently contacted with desorbent. The extract-free, desorbent containing adsorbent is recycled to the top of the adsorption zone. Toluene and isooctane can thus be separated.

U.S.P. 2,582,443. Process for Separation of Hydrocarbons. C. B. Linn to Uni-

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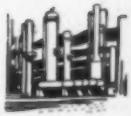

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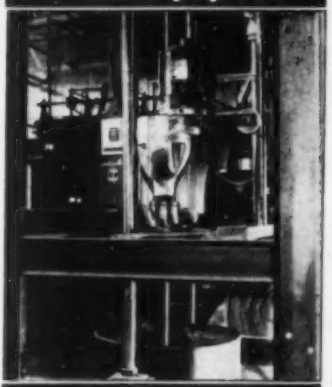

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Patents

versal Products Company.

A mixture of C_4 hydrocarbons containing acetylene is contacted with a paraffinic hydrocarbon solvent containing 3-6 C atoms per molecule, at a pressure of at least 10 atmospheres. The more saturated hydrocarbons, such as ethane, are thereby selectively absorbed, while the acetylene is separated in gaseous phase.

U.S.P. 2,582,883. Modified Double Solvent Treatment. H. C. Myers to Socony-Vacuum Oil Company, Inc.

A charge stock containing paraffinic and non-paraffinic hydrocarbons and asphaltic material is contacted with two mutually immiscible solvents, one for the paraffins and one for the non-paraffins. The resulting raffinate is more paraffinic and the extract more non-paraffinic than the charge stock. The first named solvent essentially consists of propane and 1-20 percent of an organic carbonate, while the second solvent essentially consists of phenols and cresols and at least 1.5 percent by weight of added water.

U.S.P. 2,583,090. Separation of Natural Gas Mixtures. J. L. Cost to Elliott Company.

Details are claimed of a method and an apparatus for separating natural gas mixtures and for recovering gaseous methane therefrom under substantial pressure with intermediate cooling of the compressed mixture to a low temperature and partially liquefying the nitrogen of the mixture and thereafter expanding it.

U.S.P. 2,583,352. Adsorption Process. C. H. O. Berg to Union Oil Company of California.

A gaseous mixture of low mole weight hydrocarbons containing a hydrogen halide is contacted with a moving bed of a granular adsorbent. The unadsorbed, lean gas contains the major portion of the hydrocarbons while the rich adsorbent contains the halide and some hydrocarbons. The rich adsorbent is further treated to separate the hydrogen halide from the adsorbed hydrocarbons.

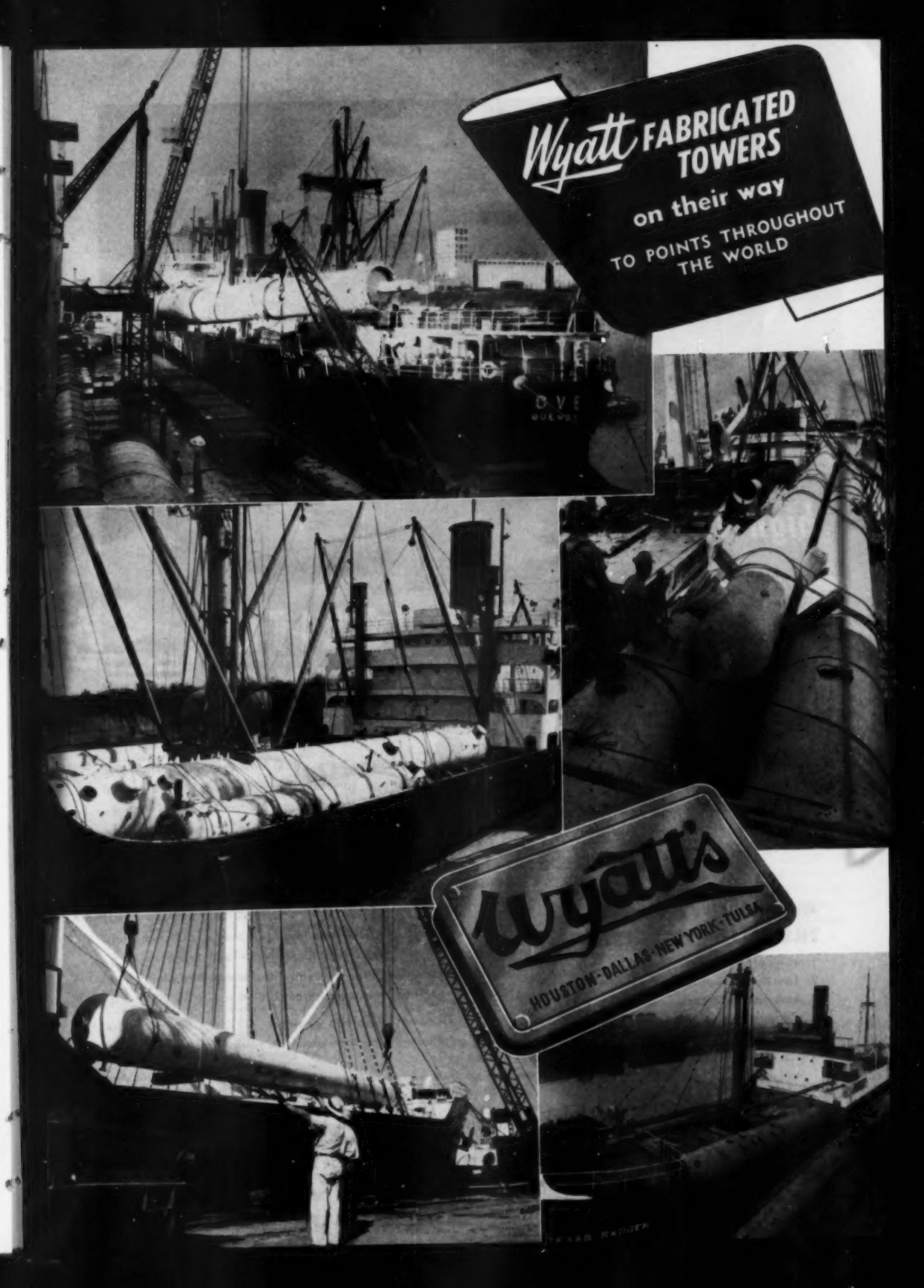
U.S.P. 2,583,518. Diesel Fuel. Primo W. Pinotti to California Research Corporation.

A California nitrogen-base-containing crude oil distillate boiling within the naphtha and gas oil range is extracted with 0.1-2 volumes of 30-50 percent H_2SO_4. An acid phase is separated, and neutralized, and an oil phase containing nitrogen bases obtained. This oil phase is added to a diesel oil having a sulfur content of 0.25-2.5 percent by weight in an amount of 0.5 to 1.5 times the weight percent of sulfur. It acts as a wear inhibiting agent.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,580,429. Catalytic Structure of Silica on Alumina-Coated-Porcelain. E. J. Houdry and J. W. Harrison to E. J. Houdry.

A catalyst structure and composition useful in the conversion of hydrocarbons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is produced by applying to an inert porcelain support a coating of active alumina and impregnating this coating with silica in a proportion of 1 silica to 2-10 alumina.

U.S.P. 2,580,641. Method of Preparing a Silica-Zirconium Oxide Catalyst for the Conversion of Hydrocarbons. J. R. Bates and G. R. Bond, Jr., to Houdry Process Corporation.

Hydrocarbon charge material is contacted under decomposition conditions with a catalyst comprising a zeolitic coagulum prepared by interreaction of a soluble silicate and a zirconium salt under pH conditions not in excess of five. The preparation of this catalyst is also claimed.

U.S.P. 2,580 647. Preparation of a Phosphoric Acid-Carbon Catalyst. M. S. Bielawski to Universal Oil Products Company.

Details are claimed of a process for the manufacture of a hydrocarbon conversion catalyst from a mixture of a finely divided vegetable material and phosphoric acid by heating to form a charred composite.

U.S.P. 2,580,806. Deposition of a Metal Oxide Catalyst on a Carrier. L. E. Malina to E. J. Houdry.

An active oxide of Al, Mg, Be, or Th is uniformly dispersed in solid finely divided form in a liquid solution of salts of the said metals with acids. The resulting mixture is applied to a catalytically inert support which is then dried and heated to form a film of the active metal oxide on the support.

U.S.P. 2,580,827. Kiln for Regenerating Adsorbents. J. W. Payne to Socony-Vacuum Oil Company, Inc.

Finely divided adsorbent materials which have become spent in the treatment of oils, such as in the refining of lubricating oils to remove gum-forming compounds, color bodies and the like, are revivified by means of an apparatus, details of which are claimed.

U.S.P. 2,581,228. SiO_2-Al_2O_3-NiO Catalyst and its Preparation. G. C. Bailey and J. A. Reid to Phillips Petroleum Company.

A polymerization catalyst consists of silica gel impregnated with 1-10 percent by weight of Al_2O_3 and 0.1-5 percent Ni in the form of NiO. The process for pree in the form of NiO. The process for preparing the catalyst is claimed in detail.

U.S.P. 2,581,670. Regeneration of Fluidized Catalyst. L. S. Kassel to Universal Oil Products Company.

Finely divided catalyst is regenerated in a fluidized state in a series of superimposed contacting and regenerating zones. Details of the process are claimed.

U.S.P. 2,582,099. Preparation of Silica-Magnesia Bead Catalyst. D. C. Braithwaite to National Aluminate Corporation.

A silica hydrogel is intimately mixed with MgO or $Mg(OH)_2$ in an aqueous slurry at a temperature of 125-175° F. for ½-1½ hours. After separation of the water, the resulting catalyst is dried. It is advantageously used in the cracking of gas oil and the like.

U.S.P. 2,582 254. Treatment of Silica-Alumina Containing Gels. Edward A.

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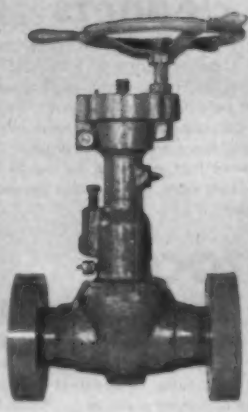

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Hunter to Standard Oil Development Company.

The impregnation of anhydrous inorganic gels with a metal oxide is claimed in which the gel is moistened to a water content between 2-20 percent and then contacted with an anhydrous organic solution of the desired metal alkoxide. The moisture in the gel hydrolizes the alkoxide. Spent silica-alumina cracking catalysts can be revivified by digestion with a halogen acid and then contacting the dried, digested gel with a solution of aluminum amyl alkoxide in a petroleum hydrocarbon boiling between 300° and 400° F.

U.S.P. 2,582,428. Preparation of Alumina-Platinum Halogen Catalyst. V. Haensel to Universal Oil Products Company.

A basic precipitant is added to $AlCl_3$. The resulting alumina containing chlorine is washed to retain 0.1-8 percent by weight of the chlorine. A Pt-containing solution is commingled therewith. The resulting composite is dried and calcined. It forms a catalyst which, generally, contains 0.01-1 percent of Pt.

U.S.P. 2,582,713. Regeneration of Fischer-Tropsch Catalyst. Homer Z. Martin and Ivan Mayer to Standard Oil Development Company.

Fluidizable Fischer-Tropch catalyst is regenerated by subjecting it to an oxidizing sintering treatment adapted to remove carbon and simultaneously agglomerate fines to larger aggregates. The thus treated catalyst is reduced with a gas generated by reaction of steam and air with a carbonaceous fuel under controlled conditions. The catalyst is then ground to a fluidizable particle size.

U.S.P. 2,582,722. Preparation of Silica-Alumina Bead Catalyst. Robert E. Schexnailder, Jr., to Standard Oil Development Company.

Solution of alkali metal silicate and alkali metal aluminate are reacted to form a hydrosol which is dispersed as fine droplets in a water-immiscible liquid at 80°-200° F. The hydrosol is converted to a hydrogel in this dispersion and its pH is then adjusted while still in dispersion to a value between 5 and 6, using glacial acetic acid. After separation from the liquid, the pH of the gel is further adjusted to 3.8-4.5, and it is then water washed free of sodium ions, dried, and activated.

U.S.P. 2,582,956. Activating Clay by Roasting with Admixed Acid Salts. G. R. Bond, Jr., to Houdry Process Corporation.

A natural hydrosilicate of aluminum, such as a sub-bentonite or montmorillonite clay, is mixed with a salt of a mineral acid furnishing acidic components which are not volatilized as such at the treating temperatures of the process, and which salt is incapable of forming on heating an insoluble cation-containing residue detrimental to catalytic activity, e.g., ammonium or zirconium sulfate. The mixture is heated to 600-1500° F. The reaction product is washed to remove water soluble conversion product. The catalytic activity of the hydrosilicate, which may be pelleted, is improved by the treatment.

U.S.P. 2,582,976. Preparation of a Sta-

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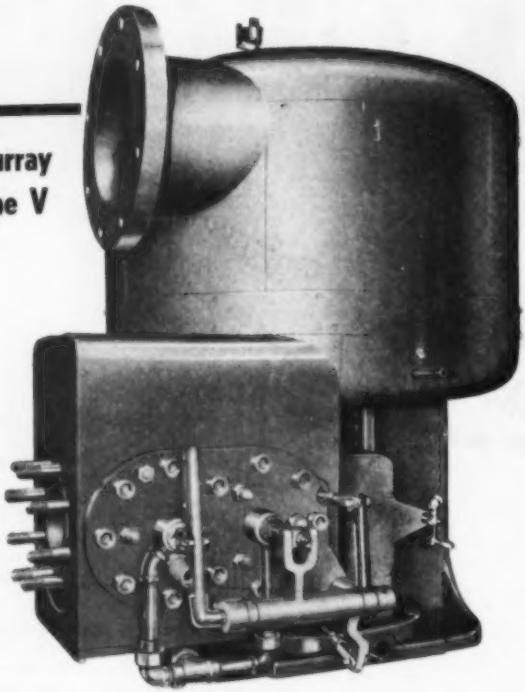

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Patents

bilized Dehydrated Montmorillonite Catalyst. E. W. M. Fawcett and J. N. Haresnape to Anglo-Iranian Oil Company, Ltd.

A mineral having a crystal lattice of the type of montmorillonite is heated to remove as water the combined hydroxyl groups from at least part of the mineral. The dehydrated product is treated with H_2S to stabilize it against rehydration. The resulting material is useful as a catalyst in the dehydrogenation and cracking of hydrocarbons, particularly of sulfur-containing feed stocks.

U.S.P. 2,583,136. Process of Regenerating an Aqueous Alkali Metal Hydroxide Solution. D. C. Bond to The Pure Oil Company.

An aqueous alkali metal hydroxide solution containing mercaptides by having been used in the extraction of mercaptans from hydrocarbons is regenerated by contacting the solution with free oxygen containing gas in the presence of a small amount of 9-anthranol as the oxidation promoter. The regeneration is stopped short of complete oxidation of the mercaptides.

U.S.P. 2,583,254. Hydrocarbon Synthesis Catalyst. Alfred Clark to Phillips Petroleum Company.

A hydrocarbon synthesis catalyst is described which comprises promoted metallic iron formed by the reduction of a comminuted fused mixture of Fe_3O_4, 0.05-1 percent of K_2O, alumina in a molecular equivalent proportion to the K_2O plus an excess of 1-2 weight percent based on Fe_3O_4, and CaO in the proportion of 1-10 percent by weight of the Fe_3O_4.

U.S.P. 2,584,452. Manufacture of Hollow Magnetite Bead Catalyst. Rhea N. Watts and William E. Spicer to Standard Oil Development Company.

Hollow microspheres containing iron, cobalt or nickel oxide are prepared by heating a wire rod of pure metal to 2000-4000° F., spraying the molten metal on the surface of a baffle in an oxidizing atmosphere at 100-300° F., so as to break up the semi-solidified metal into small particles, which are allowed to fall through an area and are recovered in solidified form in a range of 40-120 microns. An alkali metal salt promoter is then added to make improved synthesis catalysts.

CRACKING AND REFORMING

U.S.P. 2,581,163. Promoting Cracking Reactions of Hydrocarbons by the Addition of Organic Peroxides. R. T. Bell to The Pure Oil Company.

Lower-boiling liquid motor fuel is obtained by cracking hydrocarbon oil in the presence of an organic peroxide stable against explosive decomposition under shock and at ambient temperatures.

U.S.P. 2,582,920. High Purity Dicyclopentadiene. Roger T. Businger and Howard W. Gerhart to Pittsburgh Plate Glass Company.

A process for the preparation of dicyclopentadiene from a stock also containing impurities such as styrene, coumarone and indene is described which consists of selective cracking of dicyclo-

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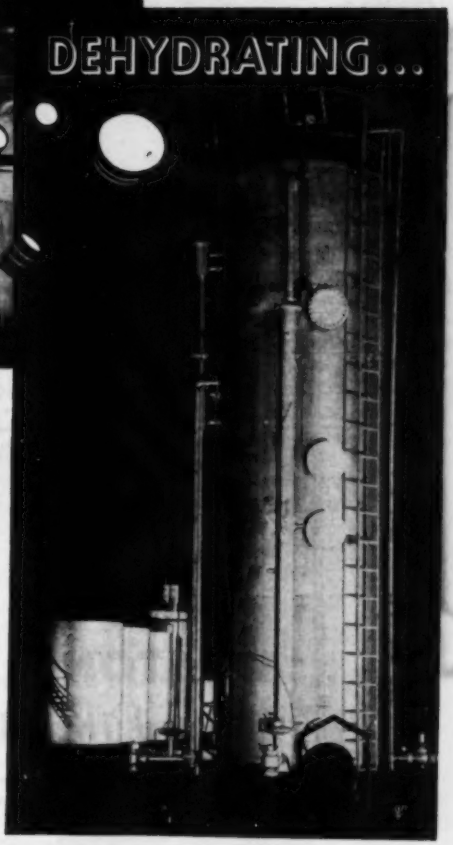

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Patents

pentadiene, separation of cyclopentadiene and impurities and polymerization of cyclopentadiene.

ALKYLATION

U.S.P. 2,581,014. Process for Methylation of Aromatics. M. H. Gorin and E. Gorin to Socony-Vacuum Oil Company, Inc.

A mixture of benzene and methylchloride in which the mole ratio of benzene to methylchloride is greater than 1:1 is continuously passed at a temperature not greater than 400° C. over a silica-alumina catalyst of specific composition which had been subjected to an acid environment in the final stages of preparation. The benzene is alkylated.

U.S.P. 2,582,047. Combination Isoparaffin-Olefin and Aromatic-Olefin Alkylation Process. H. H. Lee to Phillips Petroleum Company.

In the concomitant alkylation of an isoparaffin with an olefin and an aromatic hydrocarbon with a C_3-C_{10} olefin in two separate zones in the presence of HF, H_2SO_4, or $AlCl_3$, the emulsified reaction effluent from the first zone is directly combined with that from the second zone. The catalyst phase separated from the hydrocarbon phase of the resulting mixture is partly returned to the first and second zone and partly treated for recovery of the catalyst which is then returned to both zones.

POLYMERIZATION AND CONVERSION

U.S.P. 2,580,490. Method for Starting Up Low-Temperature Isoolefin Polymerization. D. C. Walsh, Jr., to Standard Oil Development Company.

Details are claimed of a method for polymerizing olefins at a sub-atmospheric temperature, using a mixture of a tert-monoolefin and a diolefin in an alkyl halide diluent as the charge material, and effecting the reaction in the presence of a Friedel-Crafts catalyst.

U.S.P. 2,580,766-7. Process for Manufacturing Oil Gas. E. L. Hall to American Gas Association, Incorporated.

Details are claimed for the manufacture of oil gas by the pyrolysis of petroleum oil.

U.S.P. 2,581,041. Utilization of Heat of Finely Divided Solids. H. J. Ogorzaly and W. A. Rex to Standard Oil Development Company.

Details are claimed of a process of preconditioning subdivided solids subjected to a high temperature treatment, such as subdivided oil shale preheated by hot carbonaceous shale residue.

U.S.P. 2,581,134. Apparatus for Contacting Solids and Gases. W. W. Odell to Standard Oil Development Company.

An apparatus is claimed for contacting solids with gases, particularly for effecting fluidization of finely divided solids by passing a gaseous stream upwardly therethrough. Back circulation of gaseous material is substantially reduced and the formation of large gas

pockets is prevented by the apparatus.

U.S.P. 2,581,147. Low-Temperature Iso-Olefin Polymerization with Aluminum Chloride Containing Aluminum Metal. H. G. Schutze to Standard Oil Development Company.

A tertiary mono-olefin and a diolefin with 4-7 C atoms are copolymerized at a temperature of —50° to —175° F. in the presence of a catalytic alkyl halide solution of $AlCl_3$ containing not more than 2 percent of metallic aluminum and a promoter.

U.S.P. 2,581,154. Tertiary-Butyl Halide Promoters in Friedel-Crafts Catalyzed Olefin Polymerizations. D. C. Walsh, Jr., and H. G. Schutze to Standard Oil Development Company.

A dehydrated unsaturated hydrocarbon feed stock containing a tertiary olefin and a conjugated diolefin with 4-7 C atoms in mixture with an alkyl halide and tertiary-butyl chloride or bromide is polymerized at a temperature of —220° to 0° F. in the presence of an anhydrous Friedel-Crafts catalyst. The reaction is terminated by the addition of an agent destroying the activity of the catalyst.

U.S.P. 2,581,155. Recovery of High-Molecular Weight Polymers from Hydrocarbon Solutions. D. C. Walsh, Jr., to Standard Oil Development Company.

For recovering a solid high mole weight isobutylene-isoprene copolymer catalyzed by $AlCl_3$ from a warm hydrocarbon solution, a solution of a zinc stearate anti-tack agent is employed in a manner claimed in detail.

U.S.P. 2,582,016. Process for the Production of Acetylene. H. A. Dutcher to Phillips Petroleum Company.

A propane-rich light hydrocarbon stream is continuously cracked to produce ethylene and acetylene. The reaction is carried out in several consecutive zones employing gravitating hot pebbles. Details are claimed.

U.S.P. 2,582,116. Pebble Heater Chamber Design. R. R. Goins to Phillips Petroleum Company.

The construction is claimed of a pebble heater having improved means for controlling pebble flow through the heater.

U.S.P. 2,582,246. Process for Carrying Out Endothermic and Exothermic Reactions. Paul W. Garbo to Hydrocarbon Research, Incorporated.

In an endothermic conversion process utilizing a fluidized bed of catalyst, a particulate inert solid thermophore is mixed and introduced with the catalyst. The thermophore is high in specific heat, specific gravity and thermal conductivity and has a response to a non-gravitational field of force different from that of the catalyst, so it can be separated from catalyst by subjecting the mass to such a field of force. The separated thermophore is heated above deactivation temperature of the catalyst and reintroduced into the conversion zone together with catalyst. Silica-alumina and carborundum are examples of suitable catalyst and thermophore.

U.S.P. 2,582,411. Olefin Copolymers Having Drying Properties. H. S. Bloch

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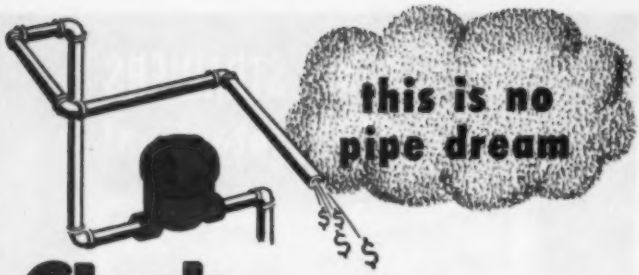

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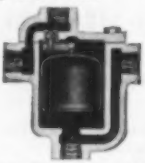

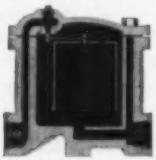

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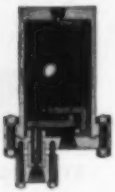

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Patents

and A. E. Hoffman to Universal Oil Products Company.

A conjugated polyolefin with not more than 8 C atoms and an iso-monoolefin with not more than 8 C atoms, are copolymerized in the presence of anhydrous HF at a temperature of —80° to —40° C. A light-stable hydrocarbon drying oil is obtained.

U.S.P. 2,582,693. Polymerization of Conjugated Diolefins. A. H. Gleason to Standard Oil Development Company.

Butadiene-1,3 or piperylene is mixed with 20-50 percent by weight of the cyclic dimer of butadiene-1,3 or the cyclic dimer of piperylene as a diluent. The resulting mixture is heated at a temperature of 130-200° C. until a substantial proportion of the monomer is converted to dimer. The thus dimerized mixture is heated to 250-400° C., until an oily to resinous polymerization product is obtained.

U.S.P. 2,582,710. Method for the Conversion of Carbonaceous Solids into Volatile Products. H. Z. Martin to Standard Oil Development Company.

Carbonaceous solids, such as oil shale, tar sands, coal, lignite and the like are converted into volatile products by carbonization and/or gasification, or the like, with preheating of the carbonaceous solids to be treated. Details of the process are claimed.

U.S.P. 2,582,711. Fluidized Carbonization Process. K. J. Nelson to Standard Oil Development Company.

Fresh subdivided carbonizable solids having a plastic temperature range, such as oil shale, tar sands, coal, lignite, and the like, are carbonized as a temperature not below the plastic range to produce volatile products. Details are claimed.

U.S.P. 2,582,712. Fluidized Carbonization of Solids. F. A. Howard to Standard Oil Development Company.

The process of this patent, details of which are claimed, relates to the same subject as that of U.S.P. 2,582,711.

U.S.P. 2,583,277. Emulsion Polymerization with a Redox Catalyst Comprising a Diazo Thioether. W. B. Reynolds to Phillips Petroleum Company.

A conjugated diene or a monomeric material containing a $CH_2{=}C<$ group, or a mixture of both materials is emulsion polymerized in the presence of a redox catalyst comprising an oil-soluble diazo thioether of the formula R—N=N—S—R^1 where R is an aromatic, radical and R^1 is an aromatic, cycloalkyl, or aliphatic radical, an aldose or ketose, and a salt of Fe, Co, Ni, or Cu.

U.S.P. 2,583,420. Controlling Heat of Reaction by Refluxing in the Butadiene Diisobutylene Copolymerization. J. D. Garber, D. W. Young, and W. J. Sparks to Standard Oil Development Company.

Details are claimed of a process for copolymerizing a major proportion of butadiene and a minor proportion of diisobutylene in the presence of an amount of cold liquid propane sufficient to obtain at all times during the reaction a mixed b.p. of +10° to —40° C., in which range the polymerization is carried through. A catalyst solution of $AlCl_3$ in methyl or ethyl chloride is used.

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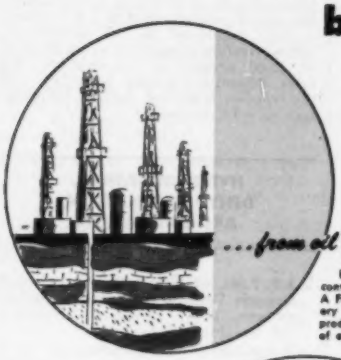
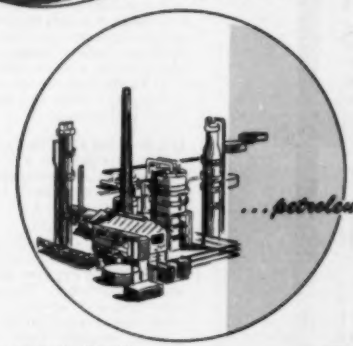


. . . from oil and gas fields

H_2S content of sour gas converted to elemental sulfur. A Foster Wheeler sulfur recovery plant in one location is producing over 300 tons/day of elemental sulfur.

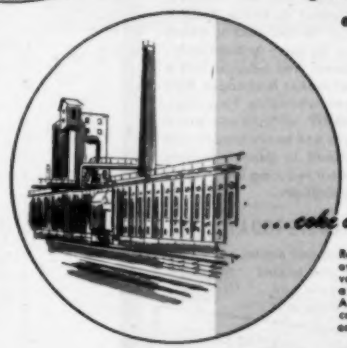


. . . petroleum refineries

H_2S gases previously "flared" and the sulfur wasted, now recovered. Two Foster Wheeler sulfur recovery plants for this service now under construction.

The unprecedented demand for Sulfur has reached a point where the world's available supply is seriously threatened. Thus, the need to find new sources for this vital element becomes one of the major items on today's agenda for full-scale production for both defense and civilian needs.

Fortunately, there is a great new source. Instead of allowing it to vanish into thin air, Sulfur is being recovered profitably from H_2S bearing gases with Foster Wheeler equipment. A quarter million tons of Sulfur per year will be recovered by Foster Wheeler plants installed or now under construction.



. . . coke ovens

Removal of H_2S from coke oven gas not only enhances the value of the gas but provides a source of elemental sulfur. A Foster Wheeler sulfur recovery plant is in operation on this service.

FOSTER WHEELER

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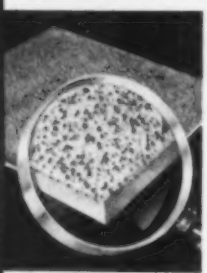

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Patents

U.S.P. 2,583,504. Process for Preparing Isoolefin-Deolefin Copolymers of Uniform Average Composition. D. W. Young, W. J. Sparks, and J. D. Garber to Standard Oil Development Company.

The polymerization process of this patent is related to that of U.S.P. 2,583,-420. An isomonoolefin with 5-8 C atoms is here employed as the second copolymerization component in an amount of 20-60 percent of the mixture. An inert diluent-refrigerant is added and the reaction is carried out at a temperature of +15° to —35° C.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,581,102. Removal of Oxygenated Organic Compounds from Hydrocarbons. L. P. Hodges to Standard Oil Development Company.

A raw feed naphtha obtained by a CO/H_2-iron catalyst synthesis is treated in the liquid state with a mixture of 90-50 percent by weight of polyethylene glycol with a mole weight of 400-4000 and 10-50 percent of an alkali metal hydroxide to free the naphtha of oxygenated compounds.

U.S.P. 2,581,118. Method of Controlling Temperatures in a Fluidized Catalyst Hydrocarbon Synthesis Process. T. C. Main to Standard Oil Development Company.

Details are claimed of a continuous method for synthesizing hydrocarbons from a CO/H_2 mixture in the presence of a fluidized catalyst admixed with solid diluent particles. These particles shall have a lower specific gravity than the catalyst particles, but at least a 2-3 times greater average size. The temperature control of the process is improved.

U.S.P. 2,581,712. Process of Extracting Oxygen Compounds from Hydrocarbon Mixture. W. Rottig to Ruhrchemie A. G.

A reaction mixture containing hydrocarbons and organic oxygen compounds is first treated with a polyvalent alcohol liquid under the process conditions, then with a mixture of polyvalent alcohol and a low mole weight monovalent alcohol, and finally with water to remove residues of the alcohols remaining in the product. The oxygenated compounds are thus selectively extracted from the reaction mixture.

U.S.P. 2,582,938. Manufacture of Synthesis Gas. D. B. Eastman and L. P. Gaucher to The Texas Company.

A CO/H_2 gas mixture free from solid carbon is produced by reacting a hydrocarbon, e.g., natural gas or a coke oven gas, with substantially pure oxygen or oxygen-enriched air containing at least 40 percent by volume of oxygen. The conversion is effected in a completely closed reaction zone of certain dimensions and free from packing and catalyst at a temperature of at least 2250° F. Further details are claimed. The effluent gas stream is continuously removed from the reaction zone.

Patents

U.S.P. 2,583,134. Catalytic Synthesis of Hydrocarbons. Harold V. Atwell to The Texas Company.

Hydrocarbons are converted to synthesis gas in the presence of a reducible metal oxide catalyst, such as oxides of Mo, W, Mn, Cr, Ti, etc. The synthesis gas is then converted to desirable hydrocarbon fractions in a Fischer-Tropsch type synthesis using iron or iron-type catalysts. The reduction product of the metal oxide is continuously recovered and passed into and through the hydrocarbon synthesis zone where it is reoxidized by the by-product water vapor formed during synthesis.

U.S.P. 2,583,164. Production of Liquid Hydrocarbons, Oxygenated Hydrocarbons and the Like. Claude W. Watson to The Texas Company.

The process employs the features of U. S. P. 2,583,134 for a carbonaceous feed material.

U.S.P. 2,583,239. Separation of Carbon Monoxide from Gaseous Mixtures. John W. Teter to Sinclair Refining Company.

Carbon monoxide is separated from hydrogen or other associated gases by selective adsorption and subsequent desorption on adsorbents comprising reducible metals such as Fe, Co, Ni, Cu, Mo, W, on a porous support. The adsorbents have been pretreated with H_2S, mercaptans, sulfides, sulfur or thiophenes to reduce their capacity to adsorb hydrogen without affecting their capacity to adsorb CO.

U.S.P. 2,583,255. Control of Catalyst Concentration. Alfred Clark to Phillips Petroleum Company.

The catalyst density in the reactor of a fluidized synthesis process is controlled at substantially constant pressure by recycling a portion of the effluent gas to the reactor along with influent gas and maintaining a substantially constant pressure differential between two vertically separated points in the reaction zone by varying the rate of recycle.

DESULFURIZATION

U.S.P. 2,580,478. Combination Process for the Catalytic Hydrodesulfurization and Reforming of Hydrocarbon Mixtures. H. M. Stine to The Standard Oil Company (Ohio).

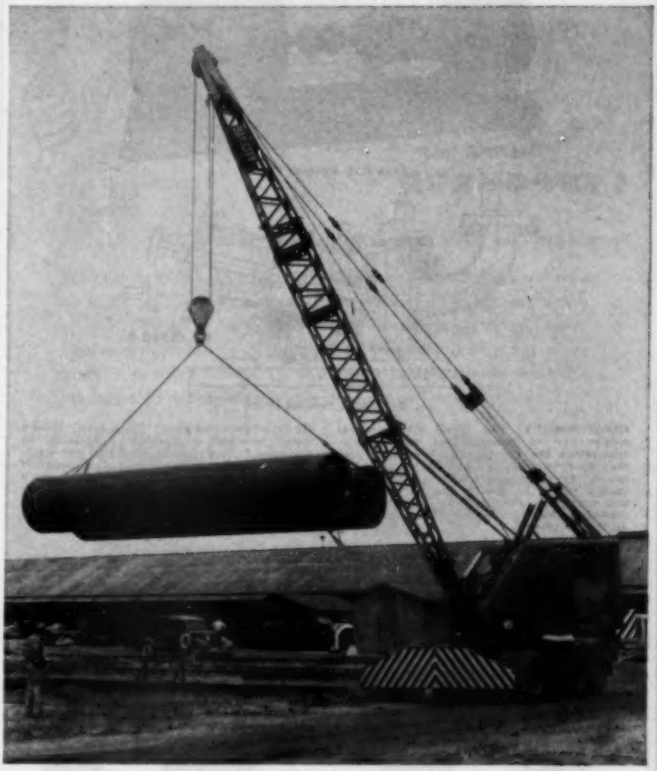
Naphtha is reformed to form gasoline of higher octane number and produce a by-product gas containing hydrogen and gaseous hydrocarbons. This gas is scrubbed at an ambient temperature with gas oil feed stock to remove gaseous hydrocarbons and provide a hydrogen enriched gas. The absorbed gaseous hydrocarbons are removed from the gas oil by heating. The hot gas oil stock is then hydrodesulfurized with the hydrogen enriched gas.

U.S.P. 2,581,061. Process for Desulfurizing Hydrocarbons with a Mixture of Ferric and Chromic Oxides. A. C. Abeel and H. J. Hibshman to Standard Oil Development Company.

A sulfur containing hydrocarbon mixture is passed over a mixture of ferric and chromic oxides prepared from a 2:1 mixture of their chlorides with ammo-

ANOTHER

MAXI-MOUNTED CRANE★



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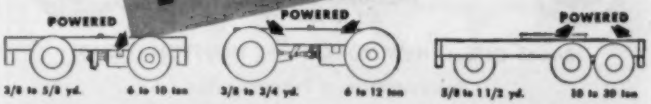

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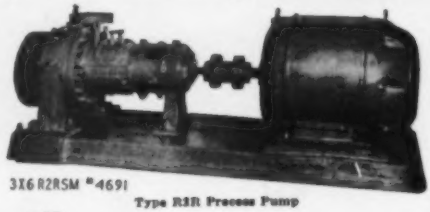
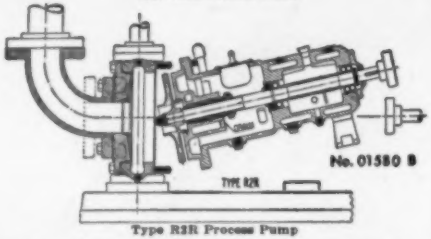


3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

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Patents

nium hydroxide at a pH of 8-9 in a special manner.

U.S.P. 2,581,135. Process for the Removal of Oxidizable Sulfur Compounds from a Hydrocarbon Gas Mixture. W. W. Odell to Standard Oil Development Company.

Organic sulfur compounds and/or H_2S are removed from a hydrocarbon gas mixture by means of a deep bed of turbulent fluidized solid particles which do not chemically react with the S-impurities in a combustion zone and which are maintained at a temperature of 300-450° C. The gas mixture preheated to a temperature of about 300° C. is passed upwardly through the bed in mixture with an oxygen-containing gas in a manner described in detail, so as to promote the controlled oxidation of the impurities to sulfur vapor without oxidizing the hydrocarbon components.

U.S.P. 2,583,083. Oxidation of Acidic Sulfur Compounds. D. C. Bond and N. B. Russell to The Pure Oil Company.

Mercaptans occurring in hydrocarbon oils are intimately contacted with a free-oxygen containing gas in the presence of a caustic alkali-solution containing an oxidation promoting amount of 2,5-ditertiary butyl hydrochinone. The oxidation is controlled to prevent destruction of the promoter. Disulfides are formed.

HEAVY OILS AND WAXES

U.S.P. 2,580,430. Catalyzed Sulfide-Hydrocarbon Reaction Products and Method of Making Same. E. C. Hughes and J. D. Bartleson to The Standard Oil Company (Ohio).

A lubricant additive is produced by reacting a saturated hydrocarbon oil with 1-20 percent by weight of a phosphorous sulfide in the presence of not over 10 percent of a halide catalyst at a temperature of 250-600° F. The product is a lubricant itself and inhibts acid and sludge formation and oxidation in mineral lubricating oils.

U.S.P. 2,580,570. Smooth-Textured Lithium-Base Greases. P. R. McCarthy to Gulf Research and Development Company.

A smooth-texture lithium-base grease comprises a homogeneous mixture of a mineral oil of a viscosity of 750-4000 SUS at 100° F., a lithium soap, and a hydrogenated rosin in certain proportions.

U.S.P. 2,580,587. Mineral Oil Composition Containing a Polymeric Alkyl Metaphosphinate. F. P. Otto and R. W. Barrett to Socony-Vacuum Oil Company, Inc.

A mineral lubricating oil contains a small amount of a polymeric alkyl metaphosphinate, e.g., the n-tetradecyl substituted compound. The additive is prepared by a reaction claimed in detail. It has pour point depressing properties.

U.S.P. 2,580,996. Wax Compositions. J. M. Butler to Monsanto Chemical Company.

A hydrocarbon wax composition contains 0.2-60 percent by weight of an alkylated polystyrene obtained by reacting

Patents

polystyrene with a propylene polymer. A coating composition is formed.

U.S.P. 2,581,092. Olefin-Diolefin Copolymers and Mercaptan Adducts. J. D. Garber and W. C. Hollyday, Jr., to Standard Oil Development Company.

A lubricating mineral oil contains a minor amount of an oil soluble condensation product of a copolymer of two parts of octadecene and one part of butadiene with an excess of tetradecyl mercaptan. The additive depresses the pour point of the oil.

U.S.P. 2,581,094. Preparation of Drying Oils. A. H. Gleason and S. E. Jaros to Standard Oil Development Company.

A conjugated diolefin with 4-6 C atoms is heated in the liquid phase at a temperature of 50-150° C. under increased pressure in the presence of a hydrocarbon soluble peroxide catalyst until not more than 80 percent of a linear oily polymer and not more than 5 percent of a dimer are formed. The entire interior surfaces of the gas space above the liquid level of the reaction zone is continually flushed with at least a portion of the liquid phase in order to reduce the formation of solid insoluble polymer. Drying oils are obtained.

U.S.P. 2,581,120. Rust Inhibiting Composition. A. H. Matuszak to Standard Oil Development Company.

A mineral lubricating oil contains dissolved therein 0.01-10 percent of an oleic acid partial ester of 2-methyl-2-nitro-1,3 propanediol. The additive has rust inhibiting characteristics. It can be replaced by similar partial esters.

U.S.P. 2,581,126. Extreme Pressure Lubricating Grease. A. J. Morway and J. J. Kolfenbach to Standard Oil Development Company.

A lubricating oil is thickened to a grease with certain amounts of a higher metal soap and a non-volatile Canizzaro reaction product of an alkali metal hydroxide and a S-containing heterocyclic aldehyde of mole weight below 200. The grease has extreme pressure properties.

U.S.P. 2,581,127. High-Temperature Lubricating Grease. A. J. Morway and J. J. Kolfenbach to Standard Oil Development Company.

A lubricating oil is thickened to grease consistency with 1-2 parts by weight of a metal salt of a low mole weight acid and 1-10 parts of a metal soap of fatty acids with 12-24 C atoms. The low mole weight acid shall be of the formula R-CO-COOH, where R is an aliphatic hydrocarbon group of 1-5 C atoms.

U.S.U. 2,581,132. Lubricating Oil. R. F Nelson, A. J. Dentser, and M. R. Hefty to The Texas Company.

A mineral lubricating oil is compounded with a minor amount of a substituted glyoxolidine. The additive enables the lubricant to form water-in-oil emulsions with the water in the discontinuous phase.

U.S.P. 2,581,573. Method for Separating Waxy and Oily Materials. J. L. Biles, H. C. Myers, T. A. Petry, and W. H. Cowell to Socony-Vacuum Oil Company, Inc.

A wax bearing mineral oil is contacted with a particle form solid adsorbent of certain particle size while the wax to be separated from the oil is maintained in

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Patents

congealed state by control of temperature in a special manner, so that the wax will remain deposited on the surface of the adsorbent.

U.S.P. 2,582,434. Production of Hydrocarbon Drying Oils Having Improved Drying Characteristics. Alfred E. Hoffman and Herman S. Bloch to Universal Oil Products Company.

Olefins containing at least 3 C atoms per molecule are subjected to conjunct polymerization in the presence of a catalyst comprising hydrogen fluoride. The polymerization procedure used to obtain drying oils is described in detail.

U.S.P. 2,582,708. Lubricating Oil Additives. S. B. Lippincott and A. H. Popkin to Standard Oil Development Company.

A waxy mineral oil is compounded with a small amount of a product consisting of an esterified condensate obtained by subjecting to a temperature of 40-150° C. one mole of an ethylene-1, 2-dicarboxylic acid, or a methylene succinic acid, or their anhydrides, and 1-4 moles of butadiene monoxide, with the use of at least one monohydric primary saturated straight chain alcohol with 8-24 C atoms as esterfying agent. The additive has pour depressing qualities.

U.S.P. 2,582,733. Metal Protecting Compositions. J. C. Zimmer and G. W. Duncan to Standard Oil Development Company.

A mineral base lubricating oil contains 1-10 percent by weight of methyl amine petroleum sulfonate wherein the mole weight of the uncombined petroleum sulfonic acid is 350-500. The composition has rust preventing characteristics.

U.S.P. 2,583,394. Extreme Pressure Greases. J. E. Schott and E. L. Armstrong to Socony-Vacuum Oil Company, Inc.

A mineral oil base is mixed with compounds of lead and of Ca, Ba, Mg, or Sr, with an amount of high mole weight saponifiable material insufficient for binding said metal compounds, and with a small proportion of a mono-basic fatty acid having 1-3 C atoms sufficient to neutralize the excess of the metal compounds. The mixture is heated under pressure for saponification and then at ordinary pressure for dehydration. A sulfurized fatty oil is added, and the mixture is then cut back with additional mineral oil to obtain a lubricating composition of desired consistency.

U.S.P. 2,583,435. High-Temperature Grease. A. J. Morway to Standard Oil Development Company.

A lubricating grease is manufactured by a process claimed in detail from a mixture of a mineral lubricating oil and a small amount of acrylic, methacrylic or crotonic acid or their nitriles.

U.S.P. 2,583,436. Heavy-Duty Lubricating Grease. A. J. Morway and E. W. Ball to Standard Oil Development Company.

A lubricating grease consists of 30-40 percent by weight of asphaltic residue of 1000-5000 S.S.U. viscosity at 100° F., 10 percent of lead soap, 8-18 percent sodium soap of rapeseed oil, 0.05-1 percent of an oil soluble petroleum sulfonate, and a mineral lubricating oil of

35-300 S.S.U. viscosity at 210° F. as the remaining part of the composition. The grease has extreme pressure and rust inhibiting properties.

PETROCHEMICALS

U.S.P. 2,581,009. Method of Preparing Thiophenealdehydes. W. S. Emerson and T. M. Patrick, Jr., to Monsanto Chemical Company.

Thiophene or a thiophene substituted by a halogen or alkyl group is reacted with an N, N-disubstituted formamide, such as N-methylformanilide, and $POCl_3$ in an anhydrous medium. The corresponding thiophenealdehyde is formed.

U.S.P. 2,581,068. Oxidation of Dicyclic Hydrocarbons. L. K. Beach to Standard Oil Development Company.

A petroleum hydrocarbon fraction of boiling range 165-185° C. containing substantial amounts of indene or hydrindene compounds is oxidized in the presence of a vanadium oxide catalyst at a temperature above 400° C. Phthalic anhydride is produced.

U.S.P. 2,581,929. Chlorination of Butadiene. K. C. Eberly and R. J. Reid to The Firestone Tire & Rubber Company.

Mono-,di-,tri-, and tetrachlorobutadienes are produced by reacting 2-3 volumes of 1,3-butadiene with 3 volumes of chlorine in 1-3 volumes of an inert atmosphere at a temperature of 350-450° C. for 0.25-4 seconds and then rapidly cooling the reaction product.

U.S.P. 2,581,988. Synthesis of Carbinols. P. van't Spijker and M. 't Hart to Shell Development Company.

In the treatment of olefins with CO and H_2 in the presence of a cobalt catalyst passed in the reaction mixture in suspension through a first carbonylation stage and a subsequent hydrogenation stage, fresh catalyst is added subsequent to the carbonylation stage. Part of the catalyst withdrawn from the hydrogenation stage is recycled to the carbonylation stage.

U.S.P. 2,583,359. Olefin Hydration. Roland F. Deering to Union Oil Company of California.

Olefins and particularly normally gaseous olefins are hydrated to alcohols at below 300° C. and superatmospheric pressure, e.g., 10 atmospheres, in the presence of a catalyst comprising orthophosphoric acid and a substantial molal excess of a carbide of an element of group IV other than carbon, e.g. silicon carbide. The orthophosphoric acid constitutes about 17-40 percent of the catalyst. The amount of steam employed is over about 15 percent of the total steam plus olefin present.

U.S.P. 2,583,413. Preparation of Alcohols. Paul H. Carnell to Phillips Petroleum Company.

A process for hydrating a mixture of aliphatic olefins having different numbers of carbon atoms per mole is described. The olefin mixture is treated in successive steps with aqueous HF which has a higher catalytic concentration in each successive step, so that the concentration is effective only for the hydration of the olefin containing the most C atoms per mole present in the step.

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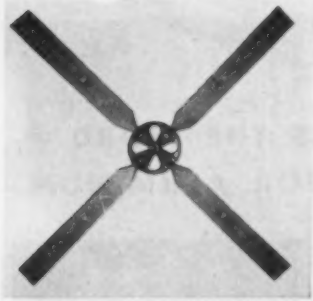

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About EQUIPMENT and SERVICE Suppliers

SERVICE PIN AWARD—Fred F. Murray, president of the Oil Well Supply Division of U. S. Steel Company, pins a 35-year service pin on Paul H. Shepherd at a recent dinner in Dallas, honoring seven employes with 15 to 35 years service. Others pictured here who were honored are, left to right, W. F. Leer, Merle D. Routzon, N. C. Nasky, Murray, H. B. Medlin, Shepherd and Alex Quayle. The seventh awardee, R. W. Roger, is not shown.

New Texas Plant Announced Under Construction by B&W

The Babcock & Wilcox Company has started construction at Paris, Texas, of the third new plant to be announced by the company within a year. The plant will get into operation this summer, and will manufacture components for large utility and industrial boilers. It will also assemble smaller FM boilers, a new integral unit recently designed by the company. Total area under roof in the new plant is 135,000 square feet as well as 1500 feet of uncovered craneway.

U. S. Steel Names Ewing Manager Stainless Steel

John S. Ewing was this month appointed manager of stainless steel sales for the United States Steel Company, succeeding Paul F. Voigt, Jr., who is retiring after 16 years with U. S. Steel and 42 years in the steel industry. Ewing had been associated with Crucible Steel Company and A. Castle and Company in Chicago prior to joining U. S. Steel in 1936 as a salesman for Carnegie-Illinois Stainless Steel Division in Chicago.

FIELD STAFF MEETING—The Emeryville, Calif., plant of Grove Regulator Company was the scene of the firm's annual sales meeting, held recently. Joining with Grove executives were 20 field sales representatives from the firm's district offices in New York, Louisiana, Oklahoma, Texas, and Southern California. Among those attending, shown above, were: (front row) E. H. McMenemy, office manager, Houston; C. W. Garrison, New York; J. A. Records, district engineer, Lafayette, Louisiana; J. D. Hicks, Corpus Christi, Texas; L. D. West and George Doty, Emeryville; (second row) A. V. Bryant, chief engineer, Emeryville; L. R. Van Arsdale, Tulsa; L. S. Robb, Dallas; W. H. Orth, Los Angeles; K. F. McIntire, H. A. Ward and M. H. Grove, Emeryville; (back row) C. B. Truitt, Southwestern sales manager, Houston; W. G. Folsom, Odessa, Texas; J. A. Mattson, New York; J. W. Collins, E. E. Mann and H. Wolpman, Emeryville. Discussions, led by M. H. Grove, covered phases of valves, regulators and controls used by the petroleum and gas industries, with emphasis centered on new products.

HOUSTON BRANCH—Refinery Supply Company of Tulsa, sister company of Central Scientific Company, Chicago, have opened a branch in Houston at 2215 McKinney Avenue. The new structure provides about 8000 square feet of space for offices, stockrooms and warehouse with adequate room for expansion. The R-S line of gas testing specialties as well as the Cenco line of scientific instruments and laboratory apparatus will be handled here.

American Brake Shoe Division Names Kelly Vice President

W. Frank Kelly has been appointed assistant vice president, and John E. Holtman, general superintendent of foundries of the American Manganese Steel Division, American Brake Shoe Company.

Kelly, his entire working career spent in the operating department of the American Manganese Steel Division, started as a foundry clerk in 1925. He became works manager in 1941, and has been general superintendent of foundries since 1946.

Holtman has been works manager of the Division's Chicago Heights plant since 1946. He started in 1930 at the Denver, Colo., plant, and was works manager there and at the St. Louis, Mo.,

New Orleans Branch Office Opened by Cooper-Bessemer

Combining regional office and warehouse, The Cooper-Bessemer Corporation recently established facilities in New Orleans to operate under the direction of T. E. Kraner, branch manager. He will be assisted by F. A. Gehres, assistant branch manager.

Gehres

Kraner

Kraner has been associated with Cooper-Bessemer since 1937 when he started in the engineering department at Mount Vernon, Ohio. In 1940 he was assigned to the Washington office to work with applications involving diesel power for naval and maritime vessels, and in 1946 was reassigned to Caracas, Venezuela. Gehres started with Cooper-Bessemer in 1939 as an application engineer and was subsequently assigned to Houston before being called for a Naval tour of duty during the war.

Diamond Attaches Polite To New Jersey Subsidiary

Long active in chlorinated solvents sales, L. J. Polite, Jr., has been transferred to the Diamond Alkali Company's Organic Chemicals Division. He will be attached to the sales staff of Kolker Chemical Works, Inc., Newark, a Diamond subsidiary specializing in organic chemicals for industry and agriculture. A graduate of Williams College, Polite served as a Naval officer in the Pacific Theater and studied radar at the Naval Academy for six months. Polite will make his home in Essex Fells, N.J.

Parker Appliance Names Agent

The Parker Appliance Company of Cleveland has appointed the Wallace Tube Company, 838 South Sixth Street, Milwaukee, as an authorized warehouse distributor for Parker tube fittings. The Milwaukee firm is under the direction of L. F. Rosenmayer.

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plant before transfering to Chicago Heights.

Bruno S. Weselis, formerly assistant works manager, has been appointed works manager at the Chicago Heights plant to succeed Holtman. Paul H. Bohlen, formerly Division trackwork engineer, has succeeded Weselis as assistant works manager.

Three Ethyl Executives Named New Directors of Corporation

Three vice presidents of Ethyl Corporation and in charge of operating functions within the company, Joseph A. Costello, B. Bynum Turner, and Sanford M. Wagner, have been elected to the board of directors.

Wagner

Costello, responsible for the coordination and planning of the corporation's activities, has been associated with Ethyl

Turner

Costello

since 1928, and has served in various management capacities in sales and manufacturing. Elected a vice president in December, 1949, he had previously served with the former Petroleum Administration for War.

Turner, vice president in charge of research and engineering, joined Ethyl in 1946. He has held several key positions in the manufacturing department, being elected a vice president in 1951. Before joining Ethyl, he was associated with the Humble Oil and Refining Company, and during World War II served with the Rubber Reserve Company as head of its butadiene-from-petroleum section.

Wagner, vice president in charge of sales, joined the corporation in 1926, less than two years after it was first organized. His entire career with Ethyl has been spent in the sales department, and he was largely responsible for the introduction of "Ethyl" gasoline on the West Coast. Wagner was elected a vice president in January, 1950.

Cowles Represents Hammer-Dahl Services in Central Texas Area

The Hammel-Dahl Company of Providence, R. I., manufacturers of automatic control equipment, has appointed Cowles & Company, Dallas, as their central Texas area sales and service representatives. Clifford A. Cowles, founder of Cowles & Company, 1923, is a graduate of Georgia Institute of Technology in mechanical engineering, and was chief engineer of the Atlantic Steel Company prior to 1923. Craig Millis and Dale Cunningham, Southern Methodist Uni-

versity graduates in mechanical engineering are associated with Cowles.

Wolverine Tube Division Names New Sales Division Managers

Wolverine Tube Division of Calumet & Hecla Consolidated Copper Company

Fox

Seekell

has announced several changes in its sales organization:

L. G. Fox, formerly manager of Wholesaler Sales, has been transferred to manager of Sales Service; S. C. Seekell, who has been in charge of Wolverine's Grand Rapids sales office, has been appointed manager of Wholesaler Sales. Both men will headquarter at the Company's General Sales Offices, 1850 Guardian Building, Detroit, Michigan.

J. A. Jolly is being transferred from the Milwaukee sales office, and will replace Seekell in Grand Rapids; D. M. Irwin, formerly affiliated with Allis-Chalmers Manufacturing Company, has completed his training program with the division, and will be placed in charge of sales in the Milwaukee area.

Mid-Continent Gas-Gasoline Raised to Fluor Division Status

Two celebrations are scheduled for Houston next month by the Fluor Corporation, Ltd. On April 4, Fluor will hold open house at its new building located on the Old Spanish Trail and built by Finger Interests of Houston. In addition, the former Mid-Continent Gas-Gasoline Department has been raised to the status of division within the company. Ernest Moncrief, manager of the Mid-Continent department, has been appointed vice president in charge of the new Mid-Continent Division.

Work has already commenced on an adjoining and identical structure. Fluor Corporation offices formerly were located in the M & M Building, Houston.

Lunkenheimer Sales Conference Told of Sales Reorganization

The Lunkenheimer Company's 90th anniversary keynoted the firm's 1952 Sales Conference in Cincinnati, Ohio, and officials and sales personnel from all over the United States and many foreign countries participated.

A reorganization of Lunkenheimer sales territories and executive appointments aimed at closer coordination of sales activities was announced, dividing the U. S. into three sales divisions—Eastern Division, under Melvin W. Pauly, sales manager; Central Division, headed by Harold H. Layritz, sales manager; and Western Division, directed by Charles W. Burrage, sales manager.

R. J. Sardieck, with headquarters in Philadelphia, has been appointed district

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Sure, the boss is supposed to send someone over to change the dial in his watchclock—but, in violation of insurance regulations, they leave this function to him—and Janikov knows a trick or two. Besides, the boiler room is a pretty comfortable place to sleep in.

If Janikov is a weekend groundhog, his boss is an ostrich executive, taking needless risks with the safety of the firm. The records are full of disasters, resulting from the negligence of unsupervised Watchmen.

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manager in the Eastern Division; E. R. Tieberman has been named district manager in the Central Division, with headquarters in Dallas, Texas; and C. B. Rosser, Jr., has assumed the post of district manager in the Western Division at Los Angeles.

OPW Corporation, Cincinnati, Names Richards, President

G. B. Richards has been elected president of OPW Corporation, Cincinnati, Ohio, manufacturers of valves, fittings, and assemblies for handling hazardous liquids. Previous to his association with OPW Corporation as executive vice president in 1949, Richards was general sales manager of the Firth Sterling Carbide and Steel Company of Pittsburgh, and of the Bostitch Company. He had also served as a sales executive with the Imperial Belting Company of Chicago, and with the Firestone Tire and Rubber Company.

Richards

Ratcliffe Named Vice President Of National Lead Company

George L. Ratcliffe, a director of National Lead Company since 1948 and general manager of the Baroid Sales Division since 1929, has been elected vice president of the company. He originally joined National Lead in 1929 as president and general manager of the California Talc Company, one of the predecessor companies to the present Baroid Sales Division. Prior to the organization of California Talc, he saw service with Standard Oil Company (New Jersey), Texas Pacific Coal and Oil Company and the General Petroleum Corporation.

Ratcliffe

Towe, Associated Since 1926, Named Cyanamid President

Kenneth C. Towe, recently elected president of American Cyanamid Company to succeed the late Raymond C. Gaugler, who died suddenly in January, has been a director of the company since 1939. Associated with the Cyanamid organization since 1926 when he was employed in the accounting department, he progressed steadily to the capacity of vice president of finance, a position which he occupied from 1945 until his election as president.

A director of several companies associated with American Cyanamid Company, including Porocel Corporation, Southern Minerals Corporation; Southern Pipe Line Corporation; and Southern Petroleum Corporation, he is also director of Cyanamid's principal subsidiaries, North American Cyanamid Ltd., Chemical Construction Corporation, and

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Cyanamid Inter-American Corporation. He is a graduate of Duke University, and was employed by Roanoke Mills Company in North Carolina, and later with the Childs Company in New York City, before joining Cyanamid. He now resides on North Street in Greenwich, Conn.

Howard Huston, vice president, American Cyanamid Company, was elected a director to fill the vacancy created by the death of Raymond C. Gaugler.

Nicholson Heads Operations for Davison Chemical Divisions

Appointment of Finley C. Nicholson to the newly created post of manager of operations of The Davison Chemical Corporation places him in charge of all production operations with the exception of the Mixed Fertilizer Division.

Nicholson

A chemical engineering graduate from Purdue University, Nicholson has been with Davison since 1942, and served most recently as manager of the Cincinnati catalyst plant. He is succeeded in that capacity by J. W. Long, formerly superintendent of silica gel operations at the Baltimore plant.

Lamson Corporation Names Coleman General Manager of Sales

Lamson Corporation recently added Robert B. Coleman to its executive staff in the capacity of manager of sales operations. A new post, it takes over the responsibilities formerly handled by the vice president of sales. This office was vacated recently by Robert I. Hicks who was named president and general manager of the company.

Hicks

Coleman

Coleman was employed by the American Chain and Cable Corporation for 15 years, most recently as eastern regional manager of the Wilson Instrument Division and the Campbell Machine Division. Hicks joined Lamson as general sales manager in 1939 and has been vice president since 1941. Prior to that he was general sales manager of the Heat Transfer Products Division, Staten Island Ship Building Company.

Salmonsen Named Manager New G-E Industry Control Department

Carl A. Salmonsen, formerly manager of manufacturing of the Large Apparatus Division and a company employe for the past 42 years, has been appointed

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general manager of the General Electric Company's newly-formed Industry Control Department. Headquarters for the new department, a component of the Switchgear and Control Division, will be in Schenectady.

Beginning as an office boy in 1909, Salmonsen has served as general superintendent and manager of the Peterborough Works of the Canadian G-E Company, Ltd., as assistant manager of the River Works at Lynn, Mass., and manager of the Philadelphia Works. In 1947 he was transferred to the Apparatus Department and in 1948 joined the Aircraft Gas Turbine Division until his promotion to Large Apparatus one year later.

U. S. Gasket Secures Harry Stott To Head Fluorocarbon Division

The United States Gasket Company, of Camden, N. J., has appointed Harry S. Stott general sales manager of both the Gasket and Packing Division of the Fluorocarbon Products Division. Stott formerly was sales manager of Raybestos-Manhattan's Packing Division.

Stott

The Fluorocarbon Products Division manufactures Chemiseal gaskets and accessories made of Teflon for glass pipe. Teflon is the trade-name for tetrafluoro-ethylene resin.

Jack Miller Heads Mid-Continent Sales For California Pump Firm

J. C. "Jack" Miller, appointed regional sales manager for the Mid-Continent area by United Centrifugal Pumps of Oakland, Calif., will work with company representatives in Tulsa, St. Louis, Denver and other points. Licensed as a professional engineer, Miller has had 17 years' experience in the petroleum industry and with centrifugal pump engineering, with service in California, New York, South America, and the Mid-Continent area.

Miller

His Houston headquarters are located in the West Building.

Dump Design Engineer Dies

Herbert A. Strom, chief designing engineer, The Weinman Pump Manufacturing Company, died early this year. Strom was associated with the company from 1935 until the time of his death except for a short time during the last World War when he was with The Tampa Shipbuilding Company at Tampa, Fla.

Prior to his initial connection with the Weinman organization, Strom served as design engineer for the Worthington Pump and Machinery Corporation, and Fairbanks, Morse and Company at Beloit, Wis.

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Kramer Named Advertising Manager for American Meter

Douglas R. Kramer, new advertising manager of the American Meter Company, has been with American Meter Company since 1944, engaging in research and development work on displacement gas meters, regulators, orifice meters and automatic control insruments. For the past few years he has been instrumental in the publication of the Company's technical literature. He is an instructor in the measurement short courses held annually at the University of Oklahoma and West Virginia University. Prior to joining American Meter Company he was with Standard Oil Company of New Jersey, designing installations and equipment for process control.

Kramer

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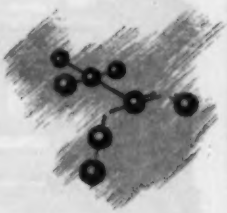

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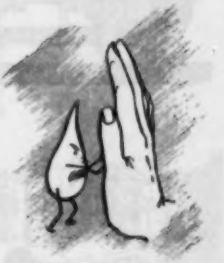

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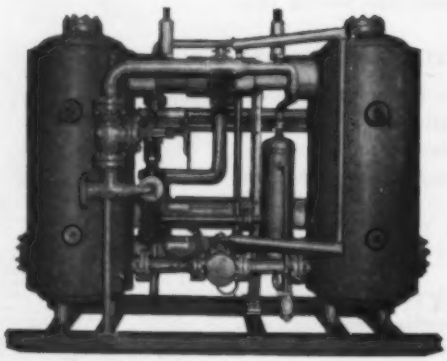

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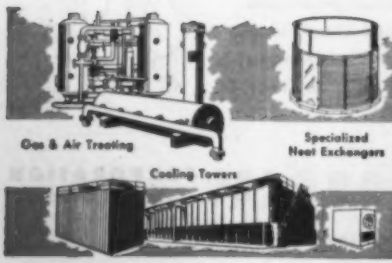

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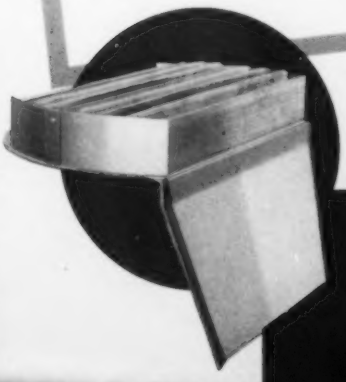

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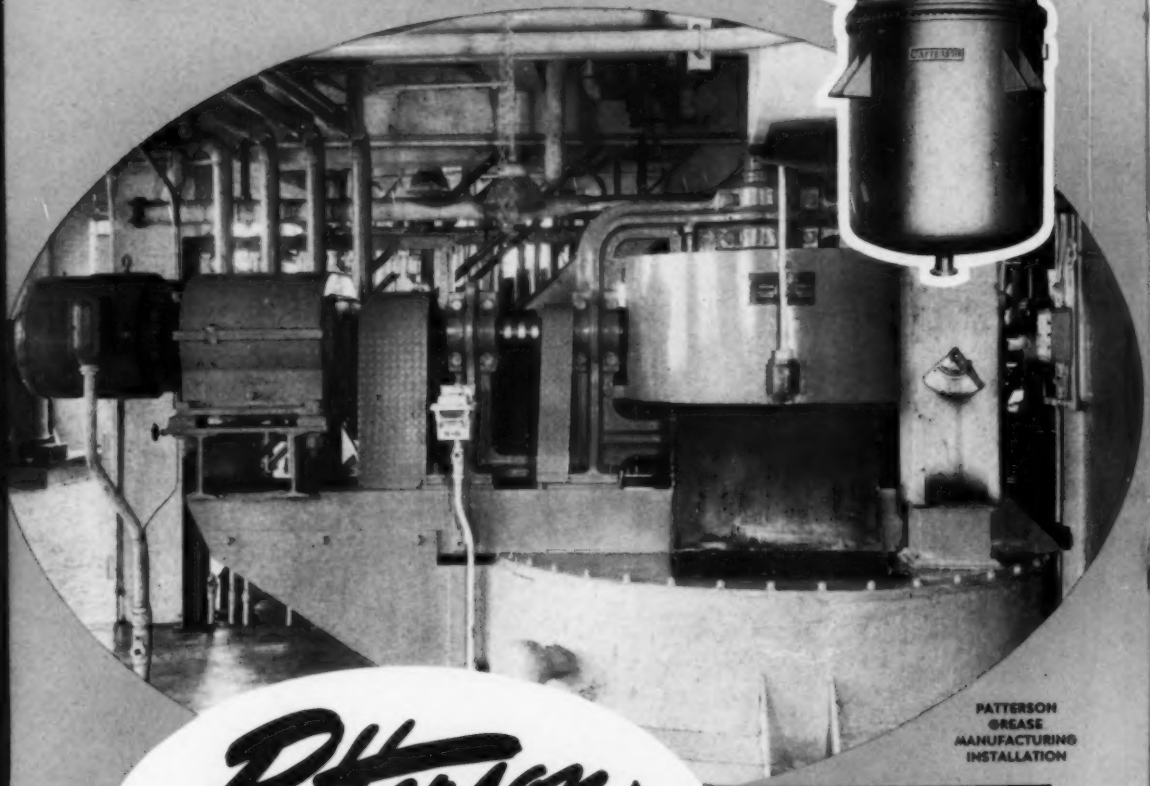

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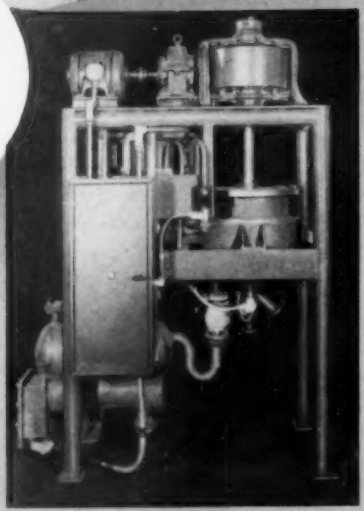

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